AN ECONOMIC PERSPECTIVE OF CROP DIVERSIFICATION IN THE SELECTED AREAS OF MYANMAR

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AN ECONOMIC PERSPECTIVE OF CROP DIVERSIFICATION IN THE SELECTED AREAS OF MYANMAR

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This thesis represents the original works of the author, except where otherwise stated. It has not been submitted previously for a degree at any other university.

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DEDICATED TO MY BELOVED PARENTS,
U BA THAN TIN AND DAW AH MAR TIN

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ABSTRACT

Supervisor Dr. Cho Cho San **Author** Soe Soe Win

This study was aimed to clarify diversification of crops and cropping patterns, and to examine economic perspectives of diversification in two different ecological areas. Sample size were selected by sample random sampling method for 150 farm households from Pindaya, Nyaung Shwe and Hsihseng Townships in southern Shan State and 170 farm households from Yamethin, Tatkone and Magway Townships in Central Myanmar. The first study done in Southern Shan State in 2013 was faced with unexpected physical accessibility, budget constraints and time limitation. Therefore, some data were not collected to cover all research objectives and second study in Central Myanmar was conducted in 2016. For two studied areas, Harfindhal index method (*Hd*) was applied to measure the level of crop diversification. Gross margin analysis and labour use efficiency were used to measure the profitability of major crops and cropping patterns for crop diversification farming in Central Myanmar. Factors influencing on crop diversification index (CDI) of farmers were analyzed by using multiple regression model.

The Harfindhal index showed that 60% of farm households having crop diversification index (0.81) practiced low diversification farming. Forty percent of farm households indicating CDI (0.39) were included in high diversification farming in Southern Shan State. In Central Myanmar, 52% low diversified farm households and 48% of high diversified farm households had diversification index of 0.62 and 0.34, respectively.

Farmers from low diversified farms in Southern Shan State (76.6%) and Central Myanmar (64.4%) were comparatively higher in primary education than that of farmers from high diversified farms in Southern Shan State (35.0%) and Central Myanmar (56.9%). Dependency ratio was about 45% in Southern Shan State and 46% in Central Myanmar.

In Southern Shan State, paddy, maize, chick pea, wheat, sesame, ginger, oilseeds and vegetables (tomato, mustard, cabbage and garlic) were found as major crops. The low diversified households cultivated these crops in mono (40%) and double (60%) cropping patterns. However, 48.3%, 28.3% and 23.3% of high diversified farm households cultivated three, four and five crops in multiple

croppings. Rice-based and maize-based cropping patterns were widely cultivated as double and multiple cropping by both diversified farms. Average cropping intensity index was 109% in low diversified and 133% in high diversified households, respectively.

The regression results were indicated that number of crops and farm size was negatively and highly significantly correlated with crop diversification index in southern Shan State. It could be interpreted that the larger the number of crops in farming and farm size, the smaller the crop diversified index would be and farm households practiced high diversified farming in the study area. It was clearly indicated that low crop diversification index meant high diversification farming. Therefore, growing the various crops should be encouraged to boost up the crop diversification at micro level.

In Central Myanmar, green gram, sesame, groundnut, cotton and cabbage were major crops. The low diversified households cultivated these crops in mono (10.5%) and double (41.2%) cropping patterns. However, 28.2%, 14.1%, 4.1% and 1.8% of high diversified farm households cultivated three, four, five and six crops in multiple croppings. Legume-based cropping pattern was commonly cultivated as common double and multiple cropping by both diversified farms. Rice-based and oilseeds-based cropping pattern were found as common double and multiple cropping patterns. The results of gross margin analysis and labour use efficiency showed that the benefit cost ratio (BCR) of cabbage crop was the most profitable (1.94) and return per labour was the highest (4.33) in mono cropping. Chilli cultivation was the second most profitable crop (1.88 of BCR) and return on labour cost was 3.89. The highest BCR of groundnut-sesame cropping pattern was 1.55 and 4.10 was found in high return per labour for double cropping. The profitable BCR of green gram-paddy-cabbage cropping pattern was 1.54 and return per labour was the 3.18 in multiple cropping. Green gram-chilli pattern was the second most profitable crop (1.98 of BCR) and 2.97 was found as return per labour cost. BCR of green gram-paddy-cabbage cropping patterns was 1.54 and return per labour was the 3.18 in multiple cropping. Green gram-groundnut-sesame cropping pattern was the second most return on labour cost (2.83) although its profit was 1.40 of BCR. Therefore, capacity of labour used in crop production was required to be efficient for high diversified households although in those of cabbage production was efficient for low diversified households.

In regression analysis, number of crops and farm size had highly negative and significant relationships with crop diversification index in Central Myanmar. It explained that larger the various crops were grown, the crop diversification value would be the best.

Keywords: Socio economic characteristics, Crop diversification, Gross Marginal Analysis, Benefit Cost Ratio, Return per Labour, Regression Analysis

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LIST OF CONVERSION FACTORS

WEIGHT CONVERSION

1 basket	=	Paddy	20.9 kg
1 basket	=	Wheat	32.7 kg
1 basket	=	Maize (seed)	24.9 kg
1 basket	=	Sorghum	28.1 kg
1 basket	=	Sesame	24.5 kg
1 basket	=	Mustard	26.1 kg
1 basket	=	Sunflower	14.5 kg
1 basket	=	Groundnut	11.4 kg
1 basket	=	Chick Pea	31.3 kg
1 basket	=	Pigeon Pea	32.7 kg
1 basket	=	Black Gram	32.7 kg
1 basket	=	Green Gram	32.7 kg
1 basket	=	Cowpea	32.7 kg
1 basket	=	Other Pulses	31.7 kg

CONVERSION IN MASS

1 pyi	=	8 nohzibu
1 basket	=	16 pyi
1 viss	=	1.64 kg (3.6 pounds)
1 kg	=	0.61 viss (2.2 pounds)
1 pounds	=	0.453 kg
1 pyi	=	2.13 kg
I inch (in)	=	2.54 cm
1 feet (ft.)	=	30.5 cm
1 acre (ac)	=	0.405 hectare (ha)
1 hectare	=	2.47 acre (ac)
1 metric ton	=	2240 pounds

CHAPTER I
INTRODUCTION

1.1 Background of the Study

Diversification can occur at the micro, meso, and macro level. At the micro level, the individual household diversifies to strengthen (reinforce) and broaden for sources of farm income. At the regional level, regions pursue agricultural activities in which they have comparative advantage. At the macro level, diversification implies the structural change from agriculture into non-farm activities, either in rural or urban areas, or in rural towns (Otsuka1998).

From this broader context, crop diversification involves the entire rural economy and entails increasing the income sources of rural households. The process involves not only cropping but also innovative marketing and agro-food-based industrial activities that affect the overall rural economy. Effective diversification, therefore, will require key investments in infrastructure and institutional changes to promote in rural area.

Thus, agricultural strategies are essential to the success of implementations at farm level, in which the income vulnerability is a primary concern to farmers. Under the given circumstance, this study was carried out to highlight for improving the economic profits in farming.

1.2 Crop Diversification in Agriculture

Although agricultural diversification is a key mechanism for economic growth, it depends on farmers' responsiveness for diversification. Agricultural diversification can be facilitated by technological breaks-through, by making changes in consumer demand or in government policy and by enhancing the development in irrigation, transportations, and other infrastructures. Conversely, it can be hampered by risks in crop management practices, in markets and prices, by degradation of natural resources, and by conflicting socio-economic requirements or self-sufficiency or foreign-exchange -earning capacity in particular crop or livestock or fishery or forest products (FAO 2002).

Cropping patterns in farming system are crucial to the improvement of economics of crop productivity for farmers. Cropping patterns approach increases the benefits derived from crop production by efficient use in resources and

socioeconomic resources (Pareek and Awasthi 2008). Moreover, socioeconomic analysis was contributed to the relationship between level of diversification and living standard at local level (Richard Anhony 2007).

Crop diversification in agriculture might be defined as an agricultural system which gives farmers a profitable livelihood while conserving agricultural resources and environmental quality. It makes efficient use of resources produced on the farm, reducing the need for commercially produced inputs (Haynes and Lamer 1983).

Crop diversification in agriculture has given three basic values; (i) ecologically sound, (ii) economically viable, and (iii) socially acceptable. Ecological soundness refers to be environmentally safe and sound by the management and natural resource base. Economic viability refers to improve productivity and profitability of crops and livestock. Social acceptability refers to enhance food security, equality, self-reliance and satisfaction of human needs.

Diversification in agriculture refers to the shift from the regional dominance of one crop to regional production of a number of crops to meet ever increasing demand for cereals, pulses, vegetables, fruits, oilseeds, fibers, fodder and grasses, fuel, etc. It aims to improve soil health and a dynamic equilibrium of the agro-ecosystem (Michelle and Aradhana 2009). Diversification in agricultural farming system is based on human goals and understanding impact of human activities on the environment in long term. Agricultural diversification introduces new management and cropping systems and it is better utilize farm resources.

Diversified rice systems in rotation with other cereals like wheat or maize optimize their use of resources. Diversified cropping systems broaden the source of a farmer's food and income, increase their land productivity, and minimize unpredictable risks such as pest and diseases in rice monoculture. Rice-based cropping systems in irrigated area are favorable environments in Myanmar with sufficient rainfall, good soil, and good market access. In addition, those cropping systems have been continuously intensified to include pulses, maize and vegetables. Because crop yields are inadequate and unstable, the income from existing cropping alone is hardly sufficient to sustain the farmers' family. Therefore, to reduce the uncertainties of the income from conventional cropping, it is essential to integrate various agricultural enterprises in the production process. In addition, crop diversification takes into account the economic returns from different value added crops and different from multiple crops which were planted in series during the

growing season (Michelle and Aradhana 2009). Likewise, crop diversified farming system makes to ensure for maximizing the net farm income to support the livelihood of farmers.

According to FAO 2002, crop diversification in agricultural development is a management of the natural resources to ensure attainment. In addition, it continues satisfaction of human needs for present and future generation. Consequently, the concepts of farm diversifying are applied to identify the constraints and condition by internal characteristics of the system.

Agricultural diversification is absolutely subdivided into crops, livestock, fishery and agro-forestry in production alternatives all around the world. Each of these sub-sectorial production activities has its own set of input requirements to allocate the resources. Therefore, human activity is responsible to allocate natural resource management at the local and regional levels.

Campbell *et al.* 2002 added to their own description of diversification by dividing it into two subcategories: agricultural and non-agricultural. Agricultural diversification includes the introduction of additional farming enterprises (e.g. beef cattle, aquaculture or tomato growing). Although agricultural diversification is associated with livestock in other countries, agriculture is considered as a crop production and accounted for future growth of agriculture into Gross Domestic Product (GDP) in Myanmar. Agricultural intensification can be achieved by changes in cropping pattern or crop diversification. Therefore, the definition of agricultural diversification in this study is only crop income in the existing cropping patterns. By diversifying the crops, the natural resource as alternative farming system was managed by farm households to survive their social and economic well-being.

Therefore, productive farms are needed to ensure proper management of using resources in crop production for the community. Moreover, crop diversity in production process is one key to increase productivity, as it preserves potential to change in agricultural practices.

1.3 Land Resources in Myanmar

By all measures, Myanmar has abundance of land compared to most of Asian countries. The total area of 676, 577 square kilometer is divided into several land types as shown in Table 1.1. Forest covers about 49% of the area and 27.4% of total land area is reserved forests. Presently, there are about 12.0 million hectares of net

sown area (17.7%) and the cultivable waste land is about 7.8% in Myanmar. Land in Myanmar is officially classified into various classes; paddy land, Yar land (dry land/upland) constitutes the great majority of area and other land types including garden, kaing, dahni and rubber according to its crop suitability (Kyaw Nyein Aung 2012).

According to current land utilization status, the land area is defined lands as mountains and plateau, plains, and river valleys. As the mountain ranges and the plateau occupy the majority of the total areas, the majority of Myanmar depends directly on a productive environment to survive. Currently, there is very limited scope for expansion of agricultural land, and increasing government and local community restriction on encroachment of land resources. The majority of dryland farmers have resorted to land use intensification as an alternative strategy for sustaining their livelihoods (Thapa and Paudel 2004).

1.4 Role of Agriculture Sector in Myanmar

1.4.1 Crop production in Myanmar

The economy of Myanmar, predominantly agro-based, is dominated by rice. Most rice production is small-scale and many farmers are growing rice at a subsistence level. According to the Food and Agriculture Organization (FAO) of United Nations Statistics Division, Myanmar is the 9th biggest exporter of rice and 2nd top exporter of beans and pulses, following Canada (Eurocham Myanmar 2016).

Out of 167.2 million acres of land in Myanmar, 19.75 million acres are used for agricultural land. The agricultural sector contributes approximately 36% of GDP and employs approximately 60% of the labour force, accounting for over 20% of export earnings. Across its varied agro-ecological contexts, Myanmar is able to grow crops such as rice, maize, sesame, pulses and beans, fruits and vegetables, as well as perennial plants, for export to international markets (World Bank 2010).

The activities for the development of agriculture are given as a first priority because it contributed the highest value of gross domestic product of the country. Agriculture sector contributed to 22.1% of Gross Domestic Products (GDP), 20% of total export earned and employed 61.2% of the labour force. Moreover, livestock and fishery sector contributed to 8.5 % and forestry sector was 0.2 % of GDP (Myanmar agriculture in brief 2015).

Table 1.1 Land utilization in Myanmar, 2016

Type of Land	Area (‘000 ha)	% of total area
Net Sown Area	12.0	17.7
Fallow land	0.4	0.7
Cultivable Waste Land	5.2	7.8
Reserved Forests	18.6	27.4
Other Forests	14.7	21.8
Other	16.7	24.6
Total	67.7	100.0

Source: Central Statistical Organization (CSO), 2016

The various crop productions and yield of selected crops in Myanmar was reveals (Table 1.2). Myanmar has good condition of weather to grow various crops: paddy, wheat, maize, groundnut, sesame, and sunflower, mustard, niger, black gram, green gram, pigeon pea, cotton and sugarcane etc. Paddy is cultivated as staple food for nation under irrigated and non-irrigated land areas. Paddy produced 3.97 metric tons per hectare on average yield in actual sown area which was 721,000 hectares in 2015-16. Maize was cultivated 472, 000 hectares and produced 3.79 metric ton per hectare on average in 2015-16. Oilseed crops play a vital role of nation due to high consumption for cooking oil compared to neighbouring countries. Major oilseed crops consist of groundnut, sesame, sunflower, mustard and niger. Total area of oilseed crops was 3, 277,000 hectares. Pulses were sown in various places in all states and regions at any cropping pattern as pulses were leading to export crop in recent years. Major pulses were black gram, green gram, pigeon pea and other beans were chick pea, cow pea, sultani, sultapya, kidney bean, etc. Annual sown area of pulses was around 450,000 hectares and pulses production was ranged from 1.23 metric ton per hectare to 1.33 metric ton per hectare from 2011 to 2016.

Furthermore, cotton was grown as industrial crop for foreign earning income. Nevertheless, cotton production had increased to 304,000 hectares in 2014-15, declined to 291,000 hectares at sown area of 1.79 metric ton per hectare in 2015-16. In addition, sugarcane also was grown as industrial crop for domestic demand of consumption. The cultivated area of sugarcane was increased about 154,000 hectares in 2014-15 and diminished to about 162,000 hectares at the sown area and produced 63.67 metric ton per hectare of average sugarcane yield in 2015-15. However, crop productivity and price in each crop make Myanmar less competitive than other neighboring countries. Therefore, economic profits are required to improve for better competitiveness.

The paddy grown area occupied about 45.4% of the total cultivated area. The second most important crop was pulses with 22.4% of total area. Then, oil seed crops (groundnut, sesame, and sunflower) occupied about 16.3% of the total cultivated area. Cereal crops such as maize, wheat and sorghum were cultivated 7.4% of total area and industrial crops including cotton, sugarcane, jute and rubber were grown on 6.9% of total cultivated area. Moreover, culinary crops such as garlic, onion, ginger and chilli were grown on 1.6% of total sown area in nation (Table 1.3).

Among all regions in Myanmar, the central dry zone is poverty stricken area and occupies approximately 13% of the country's total land areas. About 23% of the total population lives in this region and majority depends on conventional or relatively similar cropping patterns for their livelihood (JICA 2007). The dry zone which comprises Central Myanmar is at the top of the list for the production of oil seed crops (sesame, groundnut, sunflower), pulses (especially pigeon pea and green gram), and chilies and onion crops. Over 80% of oil seed crop production is emphasized in the central dry zone (Central Myanmar). The high price and trade openness for pulses lead to Myanmar to become the second largest exporter of pulses in the world. Therefore pulses account for the highest percentage in export value (72% of total agricultural export value in 2000). The black gram, green gram, chick-pea and pigeon pea are the most important crops among the pulses. Agriculture sector, therefore, still remains as the major one and it plays the vital role in development of the country. The majority of rural population still relies on agricultural activities to their livelihoods. Although rice production dominates over 45% of total cultivated area in the farming system of Myanmar, including upland area, (CSO 2016), other crops are also grown in conjunction with rice to fulfill requirements of nation. Since the land is not limited and the population is increasing gradually at the same time, land becomes very difficult to manage up with growing annual food demand. Hence, an appreciable improvement of cropping patterns is very much needed. In addition, farm communities are important to provide incentives for efficient development to compare from farm household level to regional and to national level.

1.4.2 Importance of upland farming system in Myanmar

Agricultural production in Asia, including Myanmar, mainly emphasizes intensive rice and other crops production in multiple cropping systems of the dryland areas. Available arable land is utilized to the maximum and has led to degradation. Although irrigated agriculture is well developed in high potential areas, most countries are still heavily dependent on rain-fed production systems. Productive, intensive farming methods in place of traditional subsistence farming were characterized by poor crop yields and low farm productivity.

Among countries in Southeast Asia, Myanmar is the third largest

Table 1.2 Crop production and yield of selected crops in Myanmar

(Sown Area = 000' ha)

Crops	2011-12		2012-13		2013-14		2014-15		2015-16	
	Sown Area (ha)	Yield (mt/ha)	Sown Area (ha)	Yield (mt/ha)	Sown Area (ha)	Yield (mt/ha)	Sown Area(ha)	Yield (mt/ha)	Sown Area (ha)	Yield (mt/ha)
Paddy	7.59	3.83	7.24	3.84	7.28	3.90	7.17	3.94	7.21	3.97
Wheat	236	-	246	-	250	-	244	-	238	-
Maize	412	3.61	422	3.64	441	3.70	459	3.75	472	3.79
Groundnut	887	-	914	-	931	-	949	-	955	-
Sesame	1,595	-	1,553	-	1,622	-	1,581	-	1,640	-
Sunflower	543	-	624	-	481	-	484	-	466	-
Mustard	72	-	63	-	61	-	59	-	59	-
Niger	156	-	156	-	155	-	157	-	157	-
Pulses	4.42	1.23	4.45	1.28	4.53	1.30	4.55	1.32	4.66	1.33
Black gram	1,090	1.26	1,108	1.40	1,102	1.43	1,098	1.44	1,133	1.47
Green gram	1,098	1.22	1,087	1.28	1,123	1.29	1,173	1.31	1,210	1.32
Pigeon pea	644	1.32	613	1.31	639	1.33	619	1.36	648	1.36
Other beans	870	-	880	-	877	-	866	-	864	-
Cotton	326	1.64	278	1.68	299	1.70	304	1.75	291	1.79
Sugarcane	154	63.22	154	62.26	169	61.83	181	63.41	162	63.67

Source: Central Statistical Organization (CSO), 2016 and Myanmar Agriculture Sector in Brief, 2016

Table 1.3 Sown areas of major crops in Myanmar, 2016

(Thousand hectare = ‘000 ha)

Crop Items	Area (‘000 ha)	% of total areas
Paddy	7.2	45.4
Pulses	3.6	22.4
Oilseed crops	2.6	16.3
Cereals	1.2	7.4
Industrial crops	1.1	6.9
Culinary crops	0.3	1.6
Total	15.91	100.0

Source: Central Statistical Organization (CSO), 2016

country in total rainfed area which is 99 million hectares. Myanmar occupied approximately 9 million hectares in total rainfed area in Southeast Asia (Thomas *et al.* 2002). Myanmar is highly diverse in terms of its agro-ecological zones and farming systems. It has three main agro-ecological zones such as the Delta, the Dry Zone and the hilly regions. Central Myanmar is a dry region in monsoon and a range of rain-fed crops were cultivated. The third largest agricultural zone is in the upland areas including hilly regions, dominated by Shan State in the east (Thanda Kyi 2016). The hilly region which included upland area covers approximately two-thirds of Myanmar's total land area. Farmers in hilly regions cultivate a wide range of rain-fed tree crops and horticulture crops along with rice, maize and pulses. Traditional farming systems are under stress in hilly regions as it is distinctive for most upland areas of Southeast Asia. Therefore, upland areas in hilly regions are needed to practice widely the crop diversity to increase income by upgrading the proper knowledge and technology in traditional methods.

1.5 Rationale of Study

Nowadays, the opportunities to change in the crop diversification after 2012 become acceleration in economic growth for livelihoods of rural poor in Myanmar. Although the advantages of agricultural production had in favourable agro-climatic conditions to grow high value crops, upland areas remain unproductive and the farmers are still living on subsistence level in Myanmar (Dixon and Gibbon 2001). The livelihood of inhabitants in the upland areas of Central Myanmar and Southern Shan State depends mainly on rainfed agriculture.

Myanmar's agricultural production much depends on the country's resource endowments and favourable geographic location. Due to variations in agro-ecological conditions, more than 60 different crops are grown and grouped into six categories: cereals, oilseeds, pulses, industrial crops, culinary crops and vegetables. Rice is the staple food crop for subsistence while pulses are the major commercial crops for export until recently. Pulses are also important to economy of nation not only for income-earning but also for nutrition contribution and growing to increase soil fertility in crop rotation system. In addition, seasonal vegetables such as tomato, onion, garlic and chilli also play an important role in Myanmar diet and have high demand within the domestic market (CSO 2016). Cropping systems and patterns, therefore, vary according to agro-climatic conditions within Myanmar.

Shwe Mar Than (2013) indicated that agricultural sector is a top priority of the nation's economy in recent years. However, agricultural products are not of the satisfactory record compared to other countries' performances. Moreover, agro-ecological conditions in upland area are different. Although available water for cultivation mainly depends on rainfall, rainfall is uncertain in upland area. Therefore, insufficient income and a shortage of economic assets at farm household level are vital role of poverty issues in Myanmar. To solve the shortage of income issue, crop diversifying system might be approached to increase income generation and upgrade the livelihoods of farm households.

Farming systems in upland areas are one of the greatest challenges facing in agriculture, since a balance is required between economic development and environmental protection in those areas. Upland areas are particularly sensitive to agricultural activities.

Dry zone, a part of Central Myanmar is one of the most climate-sensitive areas and having poor natural resources as well as the vulnerable to drought. In the Central Myanmar and other upland rainfed areas, mixed cropping or intercropping has been practiced (FAO 2009 and Baroang 2013). However, one of the identified problems is that, the livelihood of inhabitants in the upland areas of Central Myanmar and Southern Shan State still in the practice of the mono-cropping system resulting in low production due to continuous planting of the same crop throughout the cropping season. Therefore, local farmers have low price incentives for crops and been facing many constraints to compete with other regions due to small net return per unit area. As farmers required selecting least cost and most profitable crops through crop productions, crop diversification is important to ensure high returns to land and labour in agriculture. By explanation above, the shortage of income generation is one of the major problems in Myanmar.

Benefits of crop diversification consist of gaining additional income by growing alternative crop, reducing the cost of production and other risks from extremes in weather conditions. Furthermore, it concerns further environment degradation through an economically sound multi-commodity production system (Goletti 1999). However, studies related to crop diversification in Myanmar were reared although diversified cropping patterns had been promoted in recent years. Thus, the objective of this study is to analyse the degree of crop diversification and the factors influencing on crop diversification index of farm households in the study

areas of Myanmar. Crop diversification, for that reason, becomes a strategy to maximize the use of land and other resources for the overall agricultural development.

Crop diversification issue, therefore, is essential to fill up the gap of the research in studying as a source of better income at farm level. In addition, there is also an imperative requirement to study and compare to the profitability in crop diversification for farm households at micro level with the scare land resources in favor of production-oriented systems. Accordingly, the issues come out as the research questions.

1. What are the determinants of crop diversification?
2. What are responsives to crop diversification in resource use based on income and livelihood for study area?
3. Which crops are potential to get economic profits and higher return per labour in the crop diversification?

Although some farmers have already changed into crop diversification, some farmers are still adopting their either old cropping pattern or the mono cropping practices and managements in farming. A lot of opportunities for crop diversification took place during the new government especially in study areas. Process of agricultural diversification was encouraged improving for surrounding areas and providing new technologies related to crop productions.

For this reason, this study is crucial to be enable and to be effective the appropriate agriculture programs at regional and national plans, as research on crop diversification in Myanmar is very limited. Therefore, this study becomes an urgent need not only to strengthen the viability in crop diversification but also to improve different sources of agricultural income. Moreover, as farm households required growing and selling crops cost-effectively through crop production, cropping diversification are important to ensure high return to land and labour in agriculture. Therefore, if this study' effort made availability of the information on diversification process in future, would be improved increasingly food demand of the nation.

1.6 Objectives of Study

The general objective is to categorize the degree of crop diversification for farms based on income and to understand the crop diversifying farming within existing cropping systems. The specific objectives of this study are as follow;

1. To identify the crop diversification index and socio-economic characteristics of sample farm households in the study areas of Southern Shan State and Central Myanmar,
2. To analyze the profitability of major crops and the efficiency of labour used in crop diversification within the existing farming systems and
3. To analyze the factors influencing on crop diversification index of sample farm households in the study areas of Central Myanmar.

1.7 Scope and Limitation of Study

This study focused on various cropping patterns being practiced by farm households who have grown annual crops at Sesai, Pindaya and Nyaung Shwe Townships in Southern Shan State and Yamethin, Tatkone and Magway Townships in Central Myanmar. It investigates the determinants of crop diversification on farm households' income and profitable crops in selected farm enterprises of households. Therefore, it would be helpful to suggest valuable inputs for the basic needs of farm households, by providing information for farmers' proper cropping patterns and suggestions for policy support in order to increase farmers' income. However, this study had some limitations on selecting target group of farm households emphasized only on annual crop grown regardless of perennial crops and livestock, due to the difficulty in physical accessibility to the studied areas and budget constraints for this academic study. Therefore, the finding of this study was unable to complete covering of the economic production of all farm households in the Southern Shan State and Central Myanmar.

According to the study, findings were valuable to researchers to provide improvement on return per crop production and labor use efficiency which concern with the individual farm production at first. An effort towards this direction indicated to explore specific factors influencing on farm families' income and their livelihoods. Moreover, the appropriate policies and programs to be conducted to promotion utilization of appropriate cropping patterns for rural areas. Meanwhile, the research knowledge is beneficial to the abilities of rural community to manage proper crops diversifying farm system not only increasing crop production but also boosting Myanmar's food supply and income distribution at farm level in both Regions.

As studies on crop diversified farming in Myanmar are still limited**,** policies also expect the greater well-matched to crop diversification localities from this study. In addition, crops diversify framing systems could these specific improve sustainable production based-on land remedies using appropriate farm practices. In future, this study might help to secure food production of the upland area in long term.

In brief, this study strengthened agricultural development due to a proper choice of crop diversification by farmers and this effort direct towards sustainable crop production of agricultural sector.

1.8 Organization of Study

This study was organized in six Chapters. Chapter 1 outlined and discussed the background of the research, description of crop diversification, crop diversification in agriculture, problems related to crop production, rationale of the study and the importance of rain-fed agriculture in upland areas. Land resources and production of major crops in Myanmar also included in the study. Besides, it was included the general objective, specific objectives, scope and limitation of the study to reflect the whole image of introduction.

Chapter 2 was presented brief reviews of the literature on cropping patterns, concepts of crop diversification in agriculture. The theoretical and empirical literatures available on cropping patterns and crop diversification approach with a number of dimensions. The present review of this literature has been organized into specific issue such as concepts and definitions of cropping pattern and crop diversification, determinants of cropping pattern and crop diversification, crop diversification as a strategy to cope with costs, benefits and labour productivity of crop diversification. Then reviews of enterprise budgeting and resource endowments were described. In addition, review on socioeconomic status was presented in the adoption of cropping patterns.

Chapter 3 presented selection of the study area and an over view of geographic information in Southern Shan State and Central Myanmar include rainfall, temperature and land resources. Furthermore, crop productions of the studied areas were described in Chapter 3. Presentation of data collection, conceptual framework and data analysis for crop diversification were followed in this section. Moreover, analytical frame work includes investigating the crop diversified farming, measuring economic and social dimensions using Herfindahl Index for crop

diversification of farm households in existing cropping system. It indicated the approach to diversified cropping system for farm households in the studied areas. It described that analytical framework to determine the crop diversification of farms. In this Chapter, measuring the profitability of crop enterprises operated by farm households to survive their livelihood was presented. In addition, measuring the labour use efficiency from enterprise activities was discussed. Finally, the factors influencing on crop diversification of farm households was investigated by using regression model.

Chapter 4 presented and discussed research findings of Nyaung Shwe, Pindaya and Sesai Townships in Southern Shan State. This chapter explained the degree of crop diversification and socio-economic characteristics of farm households under different degrees of diversification including resources use and crop productivity in existing cropping system. Then, cropping patterns, cropping intensity and crop cultivated land area by diversified farm households were discussed in this chapter. Furthermore, access to credit, constraints and problems of farm households in their crop production were discussed.

Chapter 5 presented the research findings of Yamethin, Tatkone and Magway Townships in Central Myanmar. This chapter explained socio-economic status of farm households in different degrees of diversification including resources use and crop productivity in existing cropping patterns. Next, cropping patterns, cropping intensity and crop cultivated land area by diversified farm households in the study area were discussed in this chapter. In addition, analysis was carried out using enterprise analysis at first. Then, the profitability of alternative combinations of crop enterprises was assessed. Furthermore, access to credit, constraints and problems described in this chapter. Next, enterprise crop budgets were operated as spreadsheets in Microsoft, Excel 2010. Gross margin analysis on cultivating crops by diversified farm households was also discussed and labour use efficiency in their crop productions was measured in this section. Finally, this study measured factors influencing crop diversified farming of farm households in the study area.

In the last chapter, it included summary and conclusion of the result findings of the whole study area. The requirements to upgrade the existing cropping patterns were provided. Policy suggestions were discussed in chapter 6.

CHAPTER II
LITERATURE REVIEW

2.1 Cropping System and Cropping Patterns in Agriculture

Majumder (2014) analysed the nature of crop diversification in term of the changes in cropping pattern with respect to acreage and production distribution. The results revealed that the cropping pattern was increasingly dominated by boro paddy, oilseeds and potato over the three decades in West Bengal. Pulses had lost both in acreage and production in West Bengal. The indices of crop diversification mostly described an increasing degree of crop diversification over time.

Khing Thandar Soe (2012) conducted a study regarding the assessment of sustainability in rain-fed cropping system at Natmouk Township in Dry Zone Area, Myanmar. Results indicated that households head's farm experience, number of livestock, crop intensification index and growing legume crop, livestock income positive significantly influenced on the sustainability score of the cropping system in upland. On the other hand, households head's schooling year, land holding size, crop intensification index and growing legume crop, livestock income positively and significantly influenced on the sustainability score of the cropping system in low land area. However, dependency ratio was negatively significant in the sustainability score of cropping system in Natmauk Township. It suggested that crop diversification should be promoted to increase sustainability of cropping system for farm households in upland area. In addition, technology dissemination by providing training, demonstration plots and extension services also should be upgraded to boot sustainability of rain-fed cropping system.

Simien and Penot (2011) reviewed current evolution of smallholder rubber based farming systems in southern Thailand. The study presented the five main rubber based production systems in Phatthalung and Songkhla provinces. The results revealed that small holders who cultivated rice and rubber received income for the family at subsistence level. Thus, it suggested that small farms holders should be converted to rubber for diversification in a region that is already too specialized in rubber.

Singh and Park *et al*. (2011) studied farmers' perspective in the economic sustainability of cropping systems in Indian Punjab. Multistage cluster and purposive techniques were used. Farming Intensity Index (FII) was calculated using the key

indicators of agricultural sustainability i.e. per hectare agricultural production in value terms. The study compared the economic sustainability of Wheat-Rice Cropping Patterns (WRCP) to other various crop diversification efforts in Punjab in the past. It concluded that if cropping systems in Punjab become more environmentally sustainable, policy makers would need to put mechanisms in place to encourage widely sustainable WRCP.

Jha and Kumar and Mohanty (2009) measured the change in the pattern of agricultural diversification by using concentration indices in India. The study indicated that there had been significant change in the pattern of agricultural diversification at the regional level and smaller sub-regions or pockets of specialization in certain crops and crop-groups had emerged. The study pointed out the micro level evidences suggested that the certain crops were provided much money in the resource endowments and institutional framework. Farms in the region were specialized the certain crops such as fruits and vegetables since risk management had not been increased on the farm. On the other wards, the study observed that certain kind of structural changes in all sub-sectors of agriculture: crop, livestock, and fisheries.

The study of Simmons and Flora (2003) described that it is important to understand factors influencing management decisions in the level of diversification within cropping systems in northwestern Minnesota. Mental causal models which included a dominant conceptual framework (scientific) and two secondary conceptual frameworks (institutional and spiritual) were applied to reevaluate the cropping practices due to severe plant disease outbreaks and economic stresses. The study illustrated the ways farmers make decisions affecting their cropping systems diversity under conditions of agronomic and economic adversity. The study pointed to challenges for agricultural professionals and it should be expanded thinking for educational strategies to vary perspectives of farmers in the scientific mental causal model.

Hussain (1996) revealed the cropping patterns of a region are closely influenced by the geo-climatic, socio-economic, historical and political factors. On the other hand, copping pattern means the proportion of area under various crops at a point of time in a unit area. And then cropping pattern pointed yearly sequence and spatial arrangement of crops and fallow in the study area. Moreover, cropping pattern

depended on terrain, topography, slope, soils and availability of water for irrigation use of pesticides, fertilizers and mechanization.

In simple words, cropping pattern was the dynamic and there was no cropping pattern ideal for all times to a particular region. It was changing with space and time to meet the supplies and was governed largely by the physical, cultural and technological factors. The changing cropping pattern in particular time clearly indicated that the changes had been taken place in the agricultural development. These changes are caused by socioeconomic influence.

2.2 Definition of Diversification and Specialisation

Chaplin (2000) stated that diversification is defined as “the production of a variety of different articles, services’’ by considering minimum diversity as being the practice of a single system and maximum diversity as an equal distribution of all enterprises. Then, diversification was viewed as a process with four stages. Initially, diversification is a shift away from monoculture at the cropping level. Secondly, the farm had more than one enterprise for producing and selling crops at different times of year. Thirdly, diversification was understood as mixed farming. Finally, diversification might be considered as originality with respect to traditional family activities in farm. In addition, it incorporates the use of farm resources for on-farm processing and non-agricultural activities. Diversification explained as a strategy of utilising excess capacity of production factors. Although the farm household labour resources did not implicitly included within the bounds of diversification, capital and land resources are.

Within agriculture, there are reasons why a producer may specialise or diversify. The most extreme form of specialization is monoculture. Most monoculture occurs in the developed world (e.g. in the corn belts of America). Specialisation on large farms may achieve economies of scale. Kim (1981) identified five groups: (i) Available factor resources (i.e. its typology, soil type, local climate, etc.) would affect the potential cropping or livestock rearing. The available human resources would hand over knowledge and expertise about specific crops or livestock. (ii) The degree of diversification in domestic and world markets would influence the production by combination. (iii) Market access restrictions would reduce the range of produced commodities and increasing the propensity for monoculture. (iv) The infrastructure in agricultural and rural areas would affect the

availability of inputs and market access. Thus, poor infrastructure might limit the mixed production and increase the tendency towards monoculture. (v) Historical factors such as establishment created plantations left an infrastructure and resources biased towards monoculture will increase the propensity to specialization. There might also be traditional attachments to certain crops which might endow the producer with status.

2.3 Studies of Crop Diversification

Crop diversification might be useful to increase crop output under different situations. Crop diversification can be approached in two ways. The main form and the common concept are the addition of more crops to the existing cropping system, which could be referred to horizontal diversification. Crop diversification means the broadening of the base of the system by adding more crops to the existing cropping system utilizing techniques such as multiple cropping techniques coupled with other efficient management practices. It has been observed that the introduction of multiple cropping systems can help the food production potential to increase. Crop diversification is therefore considered reflective of the economic returns from different crops. Thus, concept of crop diversification is necessary to maximize profit of growing varieties of crops.

The concept of diversification conveys different meanings to different people at different levels. As crop diversification can be a useful meaning to increase crop output under different situations. And then diversification at farm level will involve growing of several crops for achieving self-sufficiency. Next, crop diversification at national level will demand more resources and require selection and management of a specific crop or a group of crops sold freshly, or value added to achieve higher profits by Gunasena (2001).

Seng (2014) analyzed the determinants of farmers' agricultural diversification: the case of Cambodia using Heckman sample selection mode with data on Cambodia Socioeconomic Survey CSES-2007. This study suggested that high relative price discourages farmers from diversifying crops. Irrigation, agricultural equipment ownership and farming expenditure, farm size, agricultural and transportation equipment were positively and significantly associated with the crop diversification and increasing intensity. In addition, the study observed that land dispute was the main institutional matter in Cambodia due to marginal-effect on crop

diversification of farmers' decision. Arable land sizes per household member, agricultural and transportation equipment had positive correlation with the diversification decision. Therefore, small scale farmers are a key limitation to decision, and reduced intensity as a result in farming.

Sharma and Singh (2013) studied agricultural diversification and contract farming in Punjab, India. The study recommended agricultural diversification as the strategy. Contract Farming was adopted by the Government of Punjab as a tool to promote diversification in the state. This study examined empirically the extent and pace of diversification using Simpson Index of Diversity. The study concluded that the Punjab's agriculture has reached a saturation point and the environmental health should be concerned. This study suggested that concrete efforts are needed by the government to the instabilities and changes to the minimal extent in agronomy to attempt crop diversification.

Ahmad (2003) analyzed the pattern of diversification at farm level in Central Plains near Bangkok and Khon Kaen, Thailand. The study indicated that its effects on farm income and constraints by farmers faced in different regions and production environments. Thailand has been successful in sector-level diversification with regional specialization. The results, however, expressed that farmers in regions were unequal to diversity towards more profitable crops in agricultural development.

Acharya and Basavaraja, *et al.* (2011) conducted a study in Karnataka using multiple linear regression analysis and stated that the crop diversification was influenced by several infrastructural and technological factors. Composite Entropy Index (CEI) has been used to analyze the nature and extent of crop diversification in the state, and the results revealed that the crop diversification influenced the production. Thus, it suggested that basic needs and sustained supply, such as water irrigation, market, fertilizer availability, proper roads and transportation should be created.

To describe the fluctuations in the term crop diversification, a study made by Luat (2001). The study included the changing of varieties and cropping patterns, increasing exports and competitiveness in both domestic and international markets, protecting the environment and favorable market condition for combining agriculture. Moreover, Jayawardane and Weerasena (2001) defined the crop diversification as the cultivation of alternative crops or adoption of alternate cropping patterns.

Sichoongwe (2014) determined the extent of crop diversification and identified the major factors influencing farmers' decisions in crop production in Zambia. In that study, bivariate statistical analysis and Tobit regression model were used to analyze the determinants of diversification. Crop diversification index (CDI) was used to measure the extent of diversification. Results revealed that the extent of crop diversification among the small holder farmers was relatively low. The study showed that landholding farm sizes, quantities of fertilizer, distance of market, plough tillage were significantly related to crop diversification. The study suggested that government should implement and encourage policies to improve farmers' access to land and agricultural implements such as ploughs, harvesting and others. In addition, trading markets should bring closer to farmers by supporting policies oriented towards. Results showed government needs to consider and undertake policies to enhance farmers' access to and control over land.

Nishan (2014) studied increasing the productivity through excessive use of chemical inputs in long term. The study pointed out the approach of diversification; horizontal diversification, vertical diversification, land based approach, water based approach, varietal diversification crop diversification for nutrient management, crop diversification for pest management and crop diversification for risk reduction. The study visualized the approach diversification as a new strategy towards enhancing and stabilizing productivity, exporting competitive and increasing net farm income and economic security in India. It concluded that crop diversification in agriculture had tremendous impact on the agro-socioeconomic areas and also in the uplifting of resource-inadequate farming communities to generate income and employment opportunities for rural youth around the year for the utmost benefits of the Indian farmers.

According to the study of Ogundari (2013), cropping pattern increased significantly with the intensification of crop diversification both the Herfindahl and Ogive indices. The result of the SFPM shows the evidence of decreasing returns-to-scale and technical progress in the food crop production in the region. Education, extension, and crop diversification were identified as efficiency increasing policy variables in the study.

The study of Sharma and Kumar *et al.* (2012) disclosed that diversification towards high-value crops albeit was slow in the regions. In regression model, importance of technology, modern implements, education, road connectivity were

determined crop diversification towards high-value crops. The study pointed out to convert many policy implications into benefits; infrastructure, public investment in the development of markets and roads. Although high-value crops had significant comparative advantage, higher production and price posed risks to cause the losses at the post-harvest stage. Therefore, it suggested that appropriate regulatory framework related to accelerated investment in food processing infrastructure could boot high-value agriculture in the region.

Myo Thet Tin (2012) studied the degree of crop diversification in Yamethin Township, Mandalay Region. It was obviously positive correlation with irrigated lands, a number of training attended and average amounts of credits at micro-level. However, land holding size and average amounts of credits were found under the same meso-level factors as the micro-level determinants of crop diversification in the study area. The effect of crop diversification showed the different impact on farm household income. The average net income of the village near the city highly increased with amount of 37% than the village far from the city.

Chakraorty (2012) studied the spatial pattern of crop diversification along with the temporal changes. Variations of crop diversification in response to fast changing physical and socio-cultural conditions are studied in 1996-1997 and 2006-2007employing Singh's (1976) index of crop diversification. For block level analysis using GIS software, the technique has been classified into various groups. Rice, jute wheat and mustard along with other pulses are the major crops diversified.

Abro (2012) studied that the determinants of crop diversification towards high value crops in Pakistan for the period 1980 to 2011by using Generalized Least Square (GLS) technique with fixed-effect model was applied. The study suggested that crop diversification was needed from low value to high value crops; from single crop to multiple crops and from agriculture production to value-added processing. In addition, the country should pay greater attention for the development of technologies, particularly in intensive fruits, vegetables and other high value crops to increase the income growth and generate effective food demand. Diversification towards high value and labour-intensive crops could provide adequate income and employment to the farmers. Infrastructure developments, length of roads, demand side factors such as per-capita income in the model were positively significant impact on crop diversification. Fertilizer and number of tube wells also were positive relationship. This meant that horticultural commodities should be enhanced to

increase crop diversification by using more fertilizer, and number of tube wells. Results described that since availability of water for irrigation purpose, crop diversification was limited in areas with higher rainfall. Therefore, farmers naturally favoured cultivating rice due to only the medium and low rainfall areas, farmers wanted to diversify to increase income and minimize risks.

Crop diversification refers to bringing about a desirable change in the existing cropping patterns towards a more balanced cropping system to increase food demand. Crop Diversification had been widely studied different perspectives in India by Mukherjee (2012). The study indicated the relationship between the crop diversification and risk using Herfindahl Index across the major states. Results showed that the relationship was positive in the case of crop diversification and yield risk. However, the relationship between crop diversification and price risk could not be included. On the other hand, World Bank (1988) explained that crop diversification was a subset of production alternatives in the agricultural sector. Therefore, an agricultural diversification strategy for the nation would be launched.

Kumar and Nanwal *et al.* (2012) suggested that crop diversification should create stabilization of farm income and promote better farm linkages among primary, secondary and tertiary sectors of economic activity in India. Moreover, highlighted issuses for adopting diversification are conservation of natural resources, earning extra income to marginal farmers, providing employment opportunities and diversity food basket in India.

Dharwad (2011) analysed that crop diversification influencing production using Composite Entropy Index (CEI) applied to multiple linear regressions in the state. The CEI for different crop groups has shown that almost all the crop groups have higher crop diversification index, except for oilseeds and vegetable crops. The study indicated that crop diversification was influenced by a number of infrastructural and technological factors.

Sharma (2011) studied about the important information to development and crop diversification. Firstly, it pointed out that committed state intervention, adoption of developmental strategies combining regional specificities should be created to enable conditions for promotion the process of crop diversification in agricultural development. Secondly, basic infrastructure facilities like transport, health, education etc. should be formed to widespread process of crop diversification in agricultural development. Thirdly, production and markets related to problems should be solved

to be innovate farmers' initiatives, experiments and adopt new production options. Fourth, economic viability and ecological sustainability should be continuous in upgraded technologies.

Kumar and Chattopadhyay (2010) analyzed that the growth of area under cultivation in different states remained stagnant in the current decades and the growth of yield of various crops has reached the saturation level in India. Efforts are now being made in different regions of India to cultivate those crops, which are remunerative and environment friendly. A number of explanatory factors have been considered to explain this phenomenon. Our findings, primarily based on official data, suggest that marginal and small farmers play a positive role in crop diversification and that has been supported by the growth of various infrastructure networks during the period under consideration.

Sharma (2007) analyzed the process of crop diversification with introduction of apple and vegetables in the State of Himachal Pradesh. Multistage simple random sampling procedure with well-structured questionnaire by using linear regression model was applied in agricultural year 2002-03. The results of regression analysis showed that access to rural credit and banks were important determination of the process of crop diversification by area under non-food grain crops.

Kurosaki (2007) revealed that the acreage share under paddy crops was higher for farmers under pressure of the local administration in diversed agro-ecological environments as delta, dry zone and hilly region of Myanmar in 2001. In addition, his paper results based on the regression estimates that the loss in rural incomes became under being forced to grow too much paddy. Thus, it was needed to initiate crop diversification in Myanmar.

Kurosaki *et al.* (2004) stated the highest poverty incidence of 54% in central dry zone of Myanmar in 2001. They also advocated that per acre income was lowest for paddy and highest for vegetables. Therefore, farm income per acre was lower in the villages where paddy cropping was more dominant, compared to that of other villages. Moreover, Kurosaki *et al.* (2004) described that low income in central dry zone was not only attributable to crop failures but also caused by the paddy output maximization policy extended to marginal regions. In addition, many countries in South East Asia, had undertaken crop diversification to enhance productivity through changing cropping patterns with high value crops with positive incomes to meet the

challenges of the globalizing market in agriculture as well as growing and changing needs of the population (Ruma 2008).

Singh (2001) pointed out that rice has remained as the most important food crop in Asia for many years. However, in marginal and upland areas of Asia, rice based cropping system had low returns. Since shifting marginal areas with rice into more profitable crops solved their livelihoods, horticultural crops were alternatively flexible cropping systems to diversify for their income sources. As a result, diversification from rice to high value crops such as fruits, vegetables and flowers has been successful in many Asian countries. In addition, the study of Singh (2001) suggested for sustaining the impact of crop diversification, to improve marketing facilities such as establishing roads, communication system and construction of wholesale market as well as access by farmers, private traders and exporters to credit.

In Vietnam, the increase of food crops was 20% and the industrial crop area was the highest 83.4% from 1990 to 1998. Diversification on rice land increased especially in the Mekong Delta and non- rice food crops only contributed 10% to food production as rotation with rice (Nguyen Van Luat 2000).

2.3.1 Advantages of Crop Diversification

Nishan (2014) stated that opportunities for crop diversification depended on risks, opportunities and the feasibility of proposed changes within socioeconomic context. This article described the major forces of crop diversification; increasing income on small farm holdings, balancing food demand, conservation of natural resources (soil, water, etc.), minimizing environmental pollution, reducing dependence on off-farm inputs, decreasing insect pests, disease and weed problems, increasing community food security and withstanding price fluctuation. Therefore, it suggested that location and specific approaches and full packages due to numerous opportunities for crop diversification should be prepared.

Mandal and Bezbaruah (2013) expressed that determinants of cropping pattern diversification, and evaluates the role of crop diversification in increasing farm income in flood affected agriculture in the plains of Assam. The study observed that farmers in Assam plains had been diversifying their cropping patterns due to flood areas related to production risks. However, it indicated that farmers who are restrained by floods regularly had gone for diversified cropping pattern to generate farm income in the study area. In addition, access to irrigation and institutional credit

might be needed due to influence crop diversification policy interventions. Thus, the results concluded that crop diversification has an important role to enhance farm income and offer important policy suggestions.

Advantages of crop diversification are comparatively high net return from crops, higher net returns per unit of labour, optimization of resource use, higher land utilization efficiency and increasing job opportunities. In order to achieve the benefits, the process of diversification should be changed from very simple forms of crop rotations to intensive systems such as relay cropping and intercropping or specialization by diversifying into various crops, where the output and processing etc., could be different. This process could be similar at farm level and national level (Gunasena 2001).

Mengxiao (2000) described crop diversification as the complex diversification patterns of agricultural cropping systems found under the conditions of farming environments. According to Johston *et al.*(1995), crop diversification has three dimensional benefits which the author described as economic, social, and agronomic.

The economic benefits include seasonal stabilization of farm income based on needs of life like education of the children; coverage of their subsistence need, especially in family food security; and reduction of risk in farm returns selected a mixture of activities which net returns have a low or negative correlation while lessening price fluctuations. Social benefit includes seasonal for farm workers while the agronomic benefits include: conserving precious soil and water resources, reduced diseases, weed and insect build up, reduced erosion, increased soil fertility, and increased yields (Ali and Beyeler 2002).

Many developing countries have incorporated a crop diversification strategy in several development programs (Gunasena 2000). Brenda (2011) studied that implement- tation to increase agricultural crop diversification might be one rationale and cost- effective method. Crop diversification could decrease pest outbreaks and dampen pathogen trans-mission, which may worsen under future climate scenarios, as well as by buffering crop production from the effects of greater climate variability and extreme events. Such benefits point toward the obvious value of adopting crop diversification to improve resilience, yet adoption has been slow. Economic incentives were encouraging production of a select few crop at the push for biotechnology strategies. However, crop diversification can be implemented in a

variety of forms and allowing farmers to choose a strategy in both increases resilience and economic benefits.

Sichoongwe and Mapemba *et al.* (2014) analysed the factors influencing the extent of crop diversification by small holder farmers in Southern Province, Zambia. The study using double-hurdle model analysis indicated that landholding size, fertilizer quantity, distance to market, and type of tillage mechanism adopted had a strong influence on whether a farmer practices crop diversification.

2.4 Income and Enterprise Budgeting Review

Narayamnamoorthy (2013) studied profitability in crops cultivation in India. Returns from crop cultivation are essential not only for the survival of farmers but also facilitate reinvestment in agriculture. Therefore, iindebtedness and other related problems were vital role of returns from crop cultivation and profitability issue in different crops for farmers were essential to gain from crop cultivation. The study indicated the profitability of six different crops; paddy (rice), wheat, gram, groundnut, sugarcane and cotton. The study concluded that reduction the various yields due to increasing inputs obviously would lead to decline in crop productivity. Therefore, the policy makers should plan and negotiate on both cost and value of output as fixed the prices for different crops need to benefits with the cost of cultivation.

Dawang and Zarmai *et al.* (2014) analyzed the economics of irrigated Irish potato production in Plateau State, Nigeria, using multistage sampling method and purposively systematic random sampling with structure questionnaire. Gross margin analysis, Benefit-Cost analysis and Sensitivity analysis were employed in the study. Results revealed that majority of farmers were educated (64.17%) adults (58.33%) with long year of experience (97%) in Irish potato irrigation farming. Cost and return analysis indicated that costs of seeds, labour and chemical fertilizers were the highest (89.40%) portion of the average total variable cost of production. Results showed that irrigated Irish potato production in Plateau State was the largest profit with robust economic viability due to value of gross margin (USD 655,637.88), benefit-cost ratio (2.64) and sensitivity analysis ratio (2.16). The study recommended technologies which minimized costs of seeds, labour and chemical fertilizers should be adopted by expansion in irrigated Irish potato production.

Cisse, Boris and *et al.* (2004) studied the profitability for groundnut was the highest gross returns and net profits per hectare and millet the lowest net profits per hectare in the centre of the Senegalese Peanut Basin. The result of the linear programming model suggested that groundnut production is the most profitable use of agricultural land in double while sorghum showed the highest profitability. The farm income analysis indicated that the level of poverty was low in the study area.

Within the agricultural enterprise, diversification may be viewed as a process with cropping level (Chaplin 2000). Another is understood as mixed farming where there is a shift of resources from one crop (or livestock) to a mix of crop and livestock.

2.5 Resource Endowments Review

Julie, Engwali and Claude.J, (2017) evaluated the efficiency of diversification versus specialization of vegetable-based farms in the West region of Cameroon. The study was employed the use of a questionnaire and stochastic frontier approach with a Cobb-Douglas model using STATA version 12.0. Results revealed that majority (71.8%) of vegetable farmers are males, and 73.4% had attained at least a primary education. Stochastic frontier analysis revealed the mean technical efficiency of vegetable farmers to be 0.863. Mean technical efficiency scores for specialized and diversified farmers were found to be 0.867 and 0.858 respectively. However, a standard t-test concluded that technical efficiency is invariant of cropping system in the results. Farm size, education, credit and membership needed to a mutual aid group, while age, sex and access to extension information and services were observed to enhance technical efficiency. The study therefore recommended extension services should give attention to farmers who belong to mutual aid groups to increase technical efficiency.

Heshmati and Rashidghalam (2016) analyzed to determine the labour productivity in the manufacturing and service sectors in Kenya. Results showed that capital intensity and wage significantly and positively affected labour productivity in 2013. In addition, training and education caused the higher labour productivity. Thus, technologies such as emails, and websites for communication were positive although it was insignificant impact on firms' labour productivity. Therefore, the study recommended that labour productivity should be promoted highly for economic growth and welfare.

Ogunbo (2015) estimated resource use efficiency and optimal farm plan in pepper production in Ogun State during the growing season in 2010. Multistage sampling technique with structured questionnaire using linear programming model was applied. The results suggested that the mean of cultivated farm size was reduced by 82.99% for pepper/tomato enterprise and 60.24% for pepper/maize/cassava enterprise. The optimum plan yielded was potential to improve output of pepper production to the optimum level. Therefore, pepper/tomato and pepper/maize/cassava enterprise were maximized the use of farm resources in the study area.

Okereke and Nwosu *et al.* (2014) assessed resource use efficiency of small holder cassava farmers in Owerri Agricultural Zone, Imo State, Nigeria. The study identified socioeconomic characteristics of smallholder cassava farmers, systems of land ownership by smallholder cassava farmers and constraints of effective allocation of farm resources associated with cassava production in the study area. In addition, it determined the relationship between cassava output and factors of production using multistage random sampling technique with structured questionnaire. Results indicated that female (63.33%) dominated in the cassava production and mixed cropping system (73.33%) was dominant in the area. In addition, use of farm size and stem cuttings and labour implied decreasing returns to scale.

Dauda, Tiamiyu and Ibrahim (2014) studied the resource use efficiency of low land rice production for total of 200 rice farmers in Katcha Local Government Area of Niger State. The result of descriptive statistic indicated that 86.5% of low land rice farmers were literate with long experience of rice cultivation as they were between the ages of 20-50 years. The marginal value product (MVP) and marginal factor cost (MFC) ratio of resource like farm size, seed material, agro chemical and fertilizer were underutilized because ratio was greater than one. In addition, family and hired labour ratio of MVP/MFC was over utilization as ratio was less than one. It meant all resources were inefficiently utilized in production function analysis. Therefore, the study recommended that the use of farm size, seed rate, agro chemical and fertilizer were increased while the use of family and hired labour should be reduced.

Likewise, Dharmasiri (2010) indicated that labor input and agricultural output was an important parameter of determining productivity of labor. Total labor force,

number of man hours scarified for farming and market value of labor were very important factors of labor productivity while considering monetary value added per man hour or man day. However, agricultural labor productivity may be enhanced through training, and increase of incentives or wages etc. Working capital may be utilized in the agricultural production process. Capital may be an important component for determining productivity of land, which further refers to enhancing efficiency of land.

Owie and Okoh (2009) studied that resource use efficiency and the farming system in Edo State of Nigeria using a multistage sampling procedure. The study revealed that there is underutilization of all the production inputs. Results indicated that land was a significant factor influencing output level of rubber in the area. The increasing return to scale was due to 1.76 of scale coefficient and rubber smallholders operated 13 farming systems in the study area. Results pointed out incorporating policy in measuring efficient use of production inputs stood towards efficient use in rubber farming system.

Ahmadzai (2007) analyzed the microeconomic determinants of the extent of crop diversification in Afghanistan using Composite Entropy Index (CEI), 2013-14. Tobit regression model was resulted that landholding size, access to sufficient irrigation water, ownership of tractor, oxen, and cattle, household size, landscape, and quality of land significantly related to the level of crop diversification. Farm households were founded that lower degree of crop diversification was in higher off-farm income. Farmers living in communities were low access to all-season drivable roads. Since off-farm income is highly likely to be associated with the unobserved household characteristics such as household entrepreneurial skills and risk preferences which are omitted from the regression analysis. One might expect biased estimates of the relevant coefficients. Tobit analysis revealed the negative impact of off-farm income was related to the level of crop diversification. This is consistent with the hypothesis that risk-aversion behavior of famers generates an upward bias in the coefficient of off-farm income if endogeneity is not allowed.

Grover and Temesgen (2006) studied impacts of existing land tenure system on agricultural development and surrounding controversial issues, implications for poverty reduction and land use efficiency at North Wollo zone in Ethiopia. Statistical tests and cluster analysis using multistage random sampling method with structure questionnaire was used and linear programming (LP) model was applied. Results

hinted that the problems faced by Ethiopian agriculture are very much related to the existing landholding system though not exclusively. The study pointed to create to encourage rural land markets for improving resource allocation, efficiency, productivity and mobility. Furthermore, policy makers and agricultural development experts should seriously consider for limited intensification in mini-plots as subsistence farms. Therefore, ways should be created viable farm size to be economic use of farm input to increase intensification in a dynamic and sustainable manner for long term perspective. The study suggested that an appropriate land policy framework was needed to address the problem of the agricultural sector.

2.6 Review related to Socioeconomic Status, Credit and Extension Services

Akaakohol and Aye (2014) analyzed the welfare effect of diversification using ordinary least square (OLS) regression model in Markurdi, Benue State. And then Logit model was applied to investigate the determinants of diversification. Results indicated that meal headed household, education and credit increased in probability of diversification while farming experience and market access decrease the probability. The OLS result described that diversification, age, education and credit had positive and significant effect on household welfare while household size had a negative effect. The study suggested that policy were important to conduct for economic growth and development. Therefore, the study pointed out that since socioeconomic characteristics influence the decision to diversity, the welfare of diversification should be effected on farm households.

Nguyen (2014) determined economic performance and household behavior in multiple crop farming in Vietnam. The farming system in Vietnam is integrated to transform to diversified farming systems between cash crops and main food cropping for scale of economies. Results observed that substantial technical inefficiency exists in multiple crop farming and between family and other inputs, excepting hired labour. Education should be enhanced and further land reforms should be conducted. The study indicated that these were the main technical efficiency shifters. The study pointed out to change the farm production for resource use efficiency in future.

Sichoongwe and Mapemba *et al.* (2014) analyzed the determinants of crop diversification as well as the factors influencing the extent of crop diversification by smallholder farmers in Southern province. The study used the secondary data of Central Statistical Office of Zambia and double-hurdle model analysis was applied.

Results indicated that farm size, fertilizer quality, distance to market and adopted type of tillage mechanism had strongly influence on farmers' practice crop diversification. Results showed government needs to consider and undertake policies to enhance farmers' access to and control over land.

The study of Abdalla and Leonhauser *et al.* (2013) assessed the degree of crop diversity and factors influencing crop diversity in dry land sector of Sudan during 2008-09 growing season. The degree of crop diversity was measured by the Shannon index using structured questionnaire and censored Tobit model applied to examine the significant socioeconomic characteristics and farm factors on the degree of crop diversity. The results showed that the study area had the low degree of crop diversity because low number of food and cash crop were cultivated. The Tobit regression model indicated that household size and level of household income level was positively related to degree of crop diversity. However, gender and use of local seeds from last year were negatively related to crop diversity. Thus, the study recommended that decision-making of female headed households should be enhanced to improve farming system. In addition, research and extension services should be improved to increase crop diversity.

Mitchell and Macleod 2006 described that a farmer might make a tradeoff between existing and expected profits to increase crop diversification. The study indicated that diversified farmers tended to be older and had larger farms, indicating that experience and business growth encourages the willingness to diversify.

CHAPTER III
RESEARCH METHODOLOGY

This chapter consists of two sections. The first section presents the description of study area including topographical condition, climate, land utilization and crop production in Southern Shan State and Central Myanmar. The second section describes the method employed in data collection, data analysis including conceptual frame work, analytical frame work and gross margin analysis. Also, the measurement of labour use efficiency was presented in this section.

3.1 Site Selection of the Study area

Myanmar has two major climatic regions, tropical and sub-topical or temperate, generally with three seasons: rainy season, winter and summer seasons. Myanmar based on agroecology zone is divided into three regions, namely the eastern hills, the central dry zone (central plains) and the western hills (coastal zone). In this study, two regions, eastern hills and central dry zone, were taken as the representatives of biophysical and socio-economic conditions of Myanmar. However, no comparison was made regarding the impact of location between two ecological zones studied at separate times. This is the major limitation of the study.

In Southern Shan State, farm households cultivate various crops for the whole year. For that reason, three townships from Southern Shan State, namely Sesai, Nyaung Shwe and Pindaya Townships were selected as the study areas in 2013. After the study areas of Southern Shan State were analyzed, collected data could not cover the objectives of the study due to various conversion rates in Shan State. Therefore, another study area, Central Myanmar, was selected in 2016 to fulfill the objectives of this study.

About 23% of total population lives in central dry zone of Myanmar and majority of people depend on agriculture for their livelihoods. However, people rely on an unstable income from agriculture with limited opportunities for their employment (JICA 2007). Therefore, the areas of Central Myanmar which include Mandalay Region, Nay Pyi Taw Council and Magway Region were selected as study areas.

Mandalay Region consists of seven districts: Kyaukse, Mandalay, Meiktila, Myingyan, Nyaung-U, Pyinoolwin and Yamethin Districts. Among them, Yamethin Township was selected as the study area due to higher possibility for measuring crop

diversification at farm level, since a wide variety of crops were cultivated in that area.

For Nay Pyi Taw, the area was composed of 8 townships, namely Pyinmana, Tatkone, Lewe, Ottarathiri, Dekkhinathiri, Poppathiri, Zabuthiri and Zayathiri townships. Among them, Tatkone township was targeted as the study area for that the vast varieties of crops were cultivated in that area, from which the measurement of crop diversification at farm level can be made easier.

In Magway Region, Magway, there are 25 townships and 1,696 villages-tracts. Therefore, this region is the largest among the study areas and various kinds of crop cultivation can be observed.

3.2 Topography of Study Area

3.2.1 Topographic situation of southern Shan State

Southern Shan State is located on the eastern part of Myanmar between 96º and 97º East longitudes and North latitude of 20º and 21º. It is bordered with the eastern and northern Shan State in the east and north, Kaya State in the south and Naypyitaw and Mandalay Division in the west. The total area of the state is 5.59 million hectares and the landform is mostly undulated with hills and slopes, where the elevation is between 900 m to 1500 m above sea level.

Southern Shan State is divided into 3 districts consisting of 24 townships, 10 sub-townships and 411 village tracts. The three districts of the State are Taunggyi, Loilin and Linkhae. Taunggyi district comprises 13 Townships, among which Kalaw Township was selected as the study area (Figure 3.1).

3.2.2 Topographic situation of Central Myanmar

The Dry Zone of Central Myanmar is roughly situated between the latitudes of 19° 20' to 22° 50' North and longitudes of 93°40' to 96°30' East, having a total land area of 6.75 million ha (16.69 million acres) making up 9.3% of the total country area (The Union of Myanmar 2005). Central Myanmar includes Mandalay Region, Nay Pyi Taw Council Area and Magway Region. Mandalay Region is surrounded by Sagaing, Shan, Kayin, Bago, Nay Pyi Taw and Magway Region (Figure 3.2). Mandalay Region covers 29,686 km2, and 29 percent of the population lives in urban areas, and the remaining 71 percent resides in rural areas (CSO 2016).

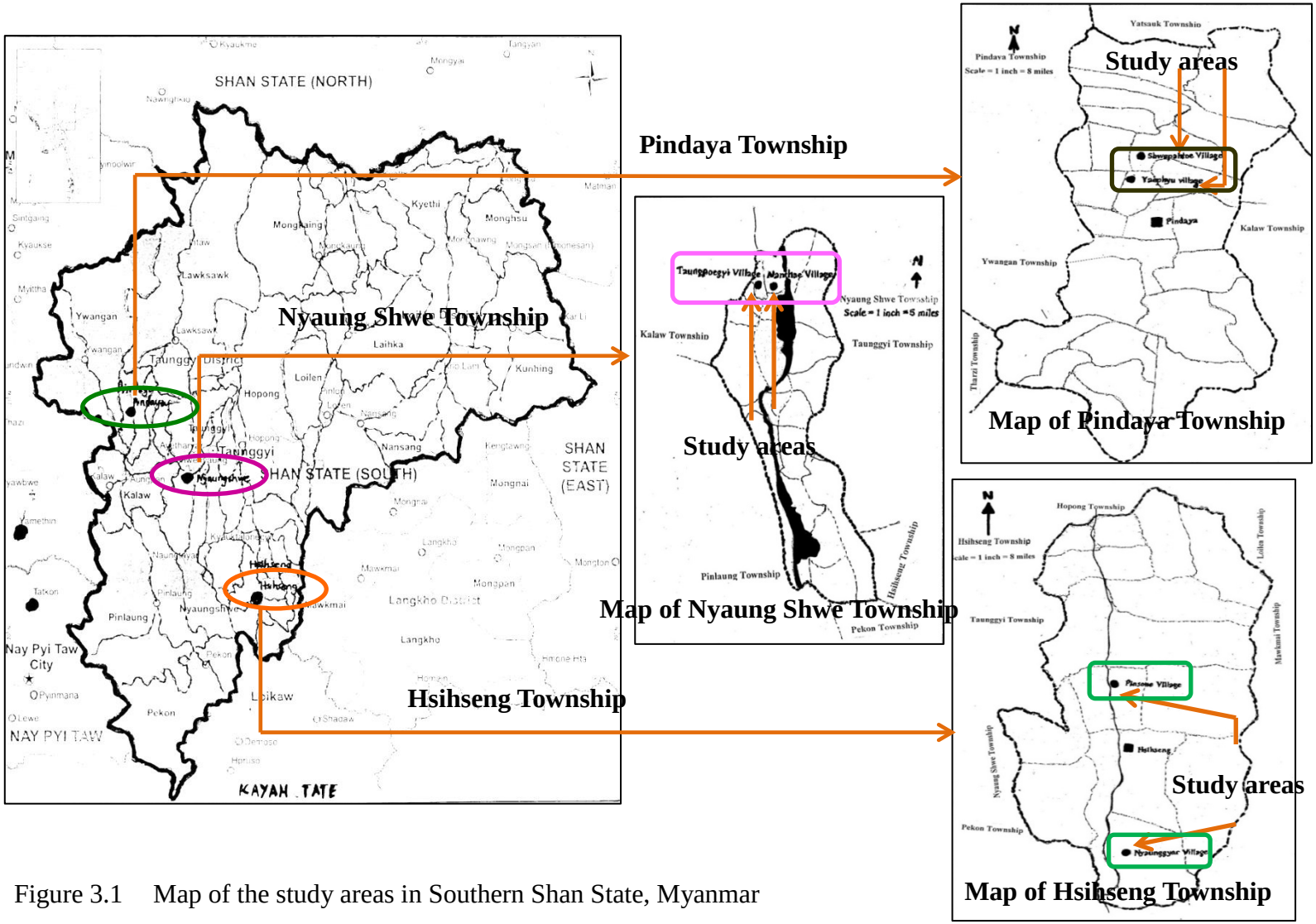

Figure 3.1 Map of the study areas in Southern Shan State, Myanmar

Among the districts in Mandalay region, Yamethin Township in Yamethin District is selected as the study area. Yamethin Township is located in between 20˚10' N to 20˚ 35' N latitude and 96˚45' E to 96˚42' E longitude (DOA 2016). Pin Long Township is bounded in the east, Thazi and Pyawbwe Townships in the north, Natmouk Township in the west and Tatkone Township in the south. Among the districts in Nay Pyi Taw Council, Tatkone Township was selected as the study areas. It is situated between 20° 20' north latitude and 96° 30' east longitude (DOA 2016). It is bounded by Taungtwingyi Township on the west, Ottarathiri, Poppathiri and Zayathiri Townships on the south and Yamethin Township on the north. Tatkone Township consists of 58 village tracts.

Moreover, Magway Region is a part of Myanmar's central Regions. Its major part falls in the Dry Zone. Magway Region is bordered with Chin and Rakhine States in the west, Bago in the south, Mandalay and Nay Pyi Taw in the east, and Sagaing in the north. Magway Region was an area of 17,305 sq-miles and is situated north latitude of 22°47' and east longitude of 95°55'. Magway Region contains 25 townships and Magway Township is situated on the east bank of Ayeyarwaddy River. In Magway Region, 15 percent of population lives in urban area and the remaining 85 percent in rural areas (CSO 2016). Magway Township is far about 240 kilometers from Mandalay and about 635 kilometers from Yangon. It borders with Meiktila Township in the east, Taungthar Township in the northeast, Nyaung Oo Township in the northwest and Yenangyaung Township in the west and southeast (Figure 3.2).

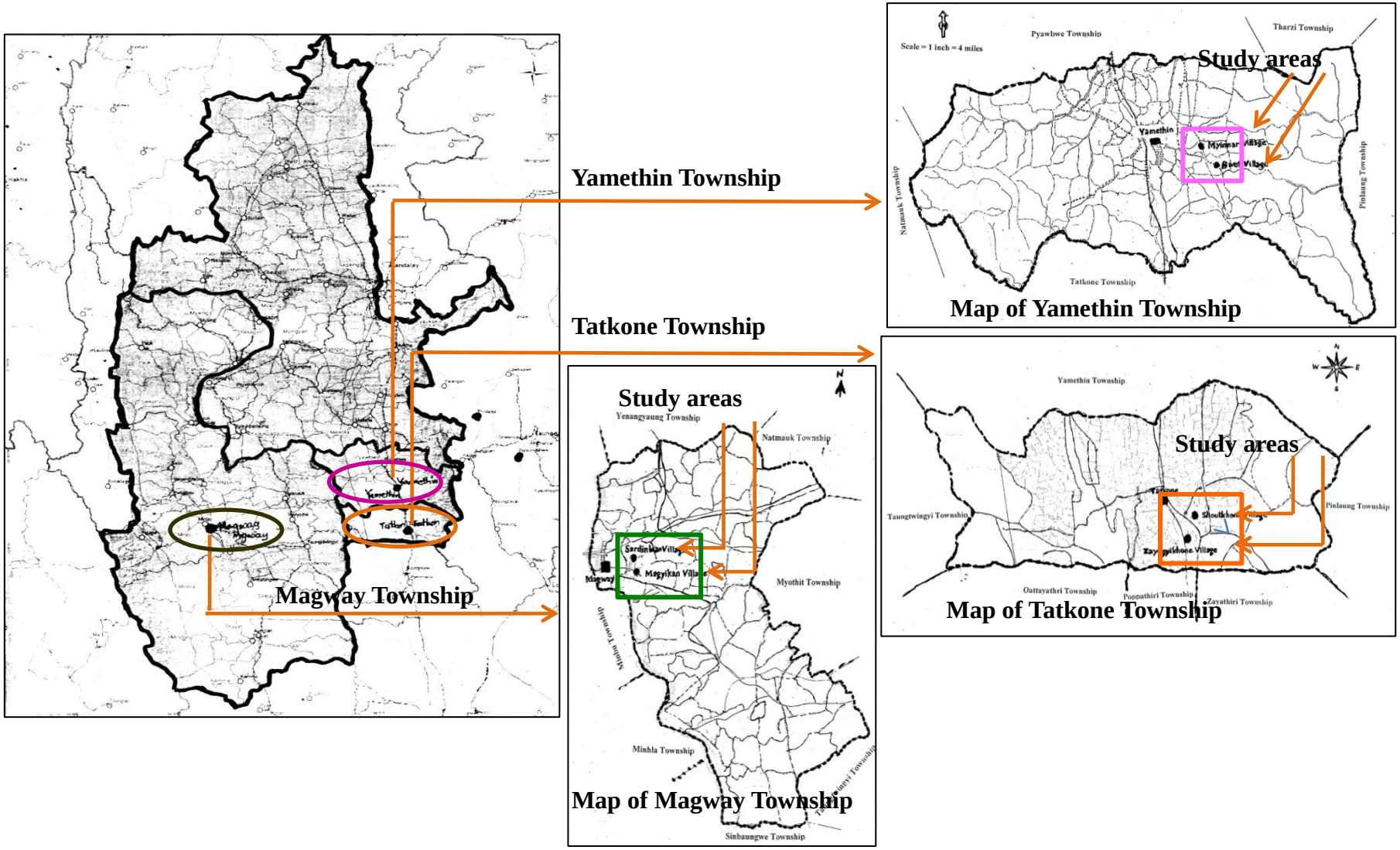

Figure 3.2 Map of the study areas in Central Regions of Myanmar

3.3 Climate of the Study Area

3.3.1 Climate in Nyaung Shwe Township, Pindaya Township and Hsihseng Township, Southern Shan State

Taunggyi district can be described as a humid subtropical area. Temperatures are very warm throughout the year, although the winter (December–February) is not very cold (milder) and nights can be quite cool. Temperature in the study area ranged from 16.7°C to 23.2°C and average humidity is about 70 percent. December, January and February are the coldest months with average minimum temperature of 16.8°C, 16.7°C and 18.2°C and the hottest months are March, April and May with 21.3°C, 23.24°C and 22.5°C respectively (Figure 3.3). Rainfall is usually heavy from May to September with over 250 mm (10 inches) except June in 2013. The average relative humidity is about 72 percent in Taunggyi District.

Average monthly rainfall in the study areas in 2013 reveals (Figure 3.4). In Hsihseng Township, average monthly rainfall was 103.8 mm and maximum rainfall was 247.7 mm in July and average minimum rainfall was 7.6 mm in December. As there was a very low annual rainfall in winter, farmers grew crops during the rainy season. Nyaung Shwe Township had a tropical climate with low temperature at high hilly area. The average minimum temperature was 16.9°C and the maximum temperature was 31.5°C. The average annual rainfall was nearly 62.9 millimeters (DOA, Nyaung Shwe Township, 2013). In Pindaya Township, the average minimum monthly temperature was 10 ºC and the average maximum monthly temperature was 34°C in 2013(DOA, Pindaya Township, 2013).

Among districts in Southern Shan State, Taunggyi district is located between 20° 47' North latitude and 97° 02' East longitudes and bordered by Thailand on the south-east and east. Taunggyi is situated at an elevation of 4,711 feet (1,436 meters) above sea level (DoA Taunggyi 2012). Taunggyi District was selected as the study area. It includes Sesai, Nyaung Shwe and Pindaya Townships. Sesai Township is situated about 25 kilometers from Taunggyi District and surrounded by Taunggyi Township in the northeast, Paekhone Township in the south-east, Maukmae and Loilin Township in the east and Nyaung Shwe Township on the west.

The topography of Nyaung Shwe area is partly hilly in the northern and southern parts, and partly plain and partly above 2950 feet (DOA Nyaung Shwe Township 2012) in the eastern and western portion.

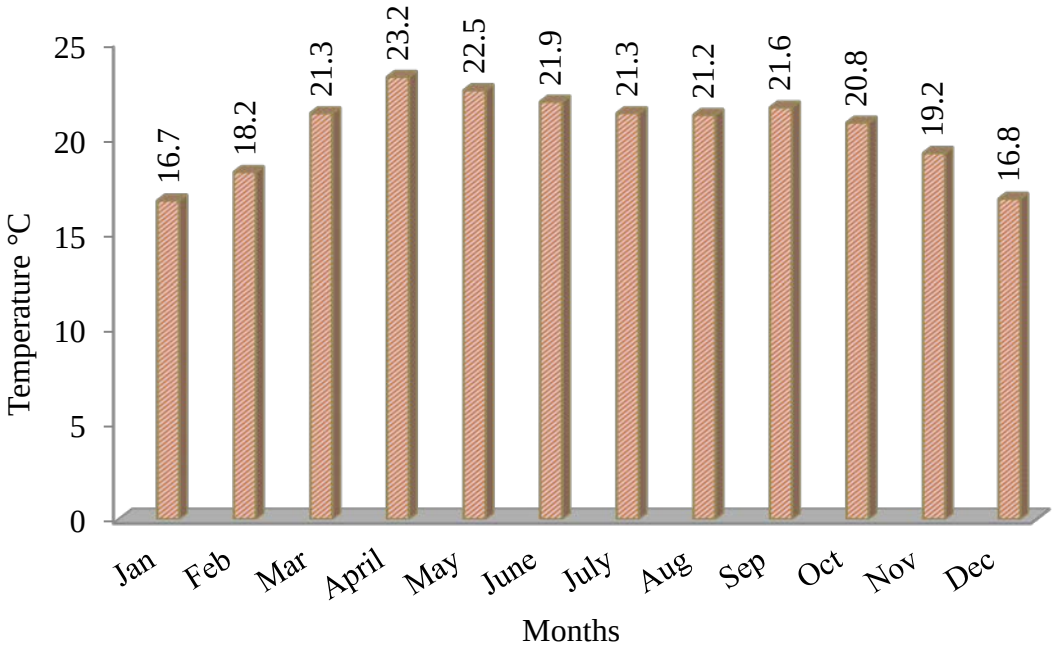

Figure 3.3 Average temperature in Southern Shan State
Source: DOA, Taunggyi, 2013

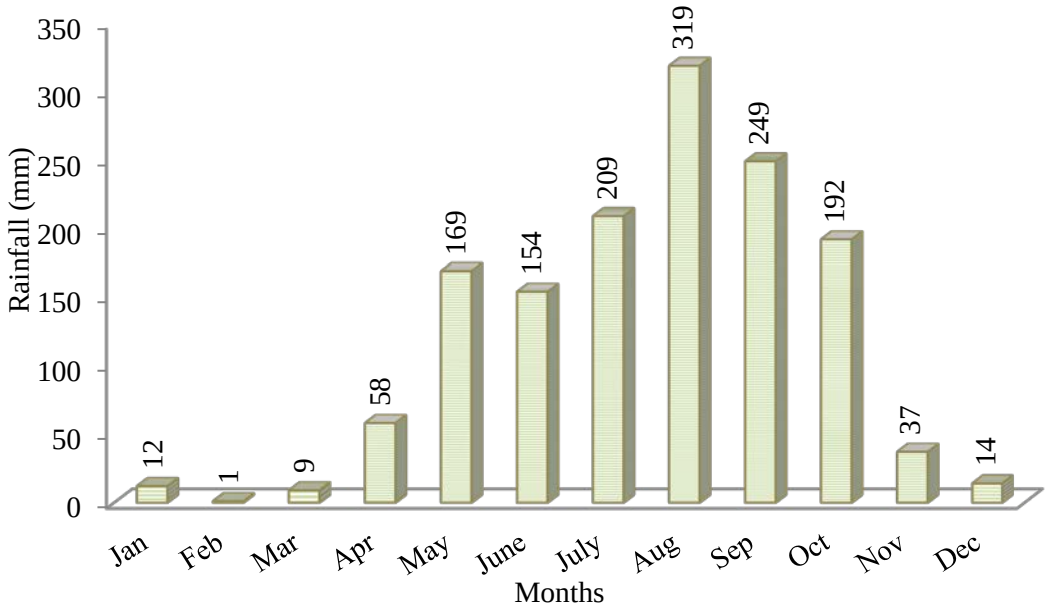

Figure 3.4 Average monthly rainfalls in Southern Shan State
Source: DOA, Taunggyi, 2013

Nyaung Shwe Township is located in the south-west of Taunggyi and situated at 30.38 kilometres from Taunggyi, 27.35 kilometres from Heho and16 kilometers from Nan Pan. Nyaung Shwe Township has a total area of 1, 408.43 square kilometers and is located between North latitude 19°58' and East longitude 97°46'and 97° 55' with elevation 2,950 feet above sea level. It can be accessible by road transport through the Kalaw-Taunggyi Road, the Shwe Nyaung- Yatsauk Road, the Aungban-Pinlaung-Pekone Road and the Heho-bawsaing Road. The township was bounded by Taunggyi Township in the north-east, Pin Long Township on the south-west, Hsihseng Township on the east and Kalaw Township in the west. Moreover, Pindaya Township, selected as the study area, is located between 20° 7' North latitude and 95° 10' East longitude. It is at an elevation of around 570 feet or 174 meters. It is bounded by Kalaw Township in the east, Ywangan Township in the west, Yatsauk Township in the north and Thazi Township in the south-eat. Farm households in Pindaya Township cultivated various crops such as rice, wheat, ginger, tea and various vegetables during rainy season and some vegetables are cultivated the whole year.

3.3.2 Climate in Yamethin, Tatkone and Magway Townships, Central Myanmar

The study areas in Central Myanmar included Yamethin, Tatkone and Magway Townships. Sufficient rainfall in Myanmar received from May to late October during the rainy season, except in the dry zone area. The annual rainfall in the central part of Myanmar is less than 600 mm (UNCCD 2000). The Central dry zone areas received limited rain compared to country’s averages as it is situated in the shadow of the Rakhine mountain range. Therefore, the Central Myanmar has very severe climatic condition.

Average temperature of Yamethin Township ranged from 22°C to 32°C (Figure 3.5). Average annual rainfall is from 100 mm to less than 200 mm in May-October, except July (less than 70 mm). The average relative humidity is about 67 percent in 2016 (Figure 3.6).

In Tatkone Township, an annual rainfall is less than 70 mm. Average temperatures of Tatkone Township ranged from 23.7°C to 30.8°C in 2016 (Figure 3.7). The annual rainfall in Tatkone Township is from 100 mm to nearly 150 mm. The average relative humidity was about 65 percent in 2016 (Figure 3.8).

Magway Township in Magway Region is located in the central dry zone. With an annual rainfall of less than 80 mm, it is regarded as the hottest and driest part of Myanmar. Average temperature of Magway Township was from 22°C to 32°C in 2016 (Figure 3.9). The annual rainfall of Magway Township was from 150 mm to nearly 200 mm, with the average relative humidity of about 69 percent in 2016 (Figure 3.10).

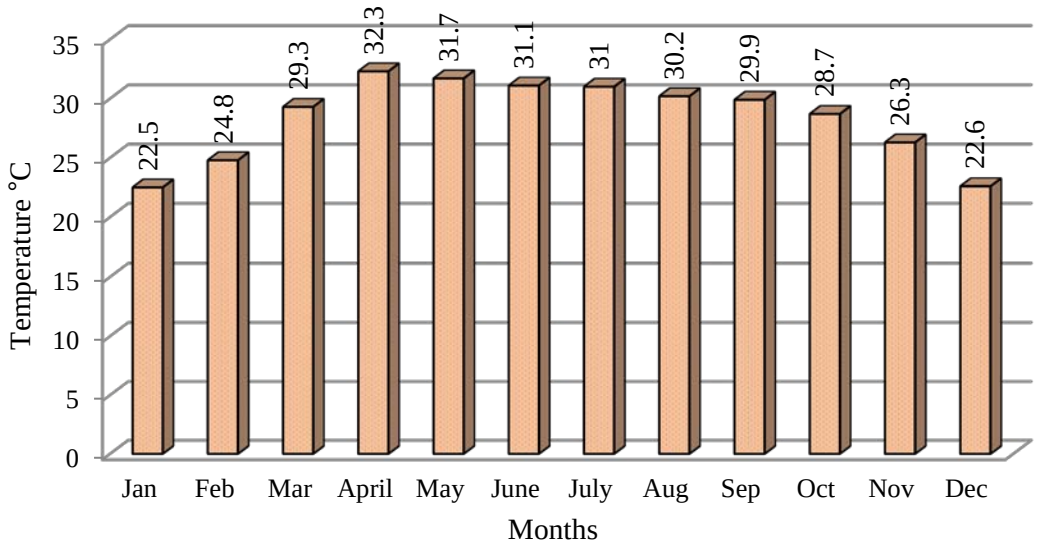

Figure Average Temperature in Yamethin Township

Figure 3.5 Average temperatures in Yamethin Township, 2016
Source: DOA, Yamethin, 2016

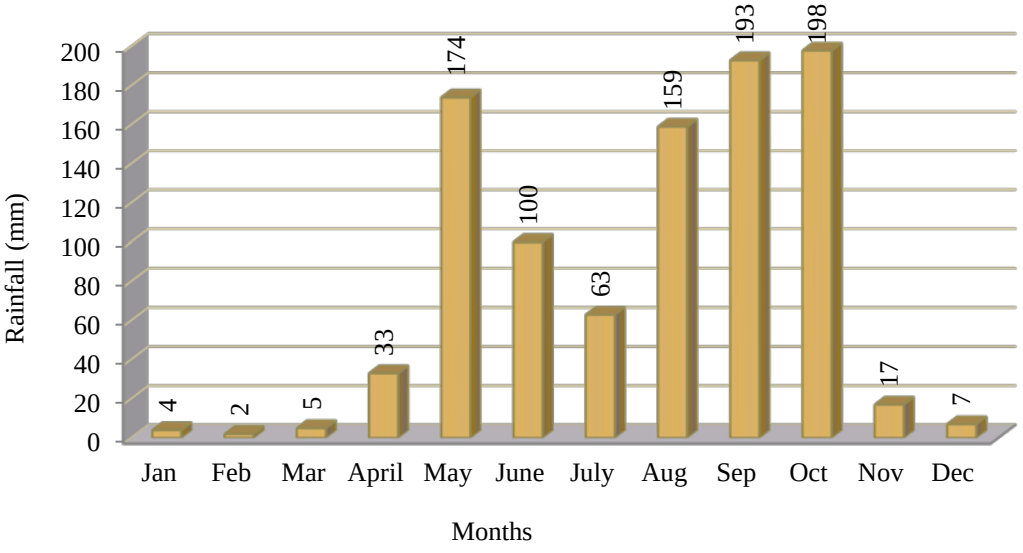

Figure 3.6 Average rainfall in Yamethin Township, 2016
Source: DOA, Yamethin, 2016

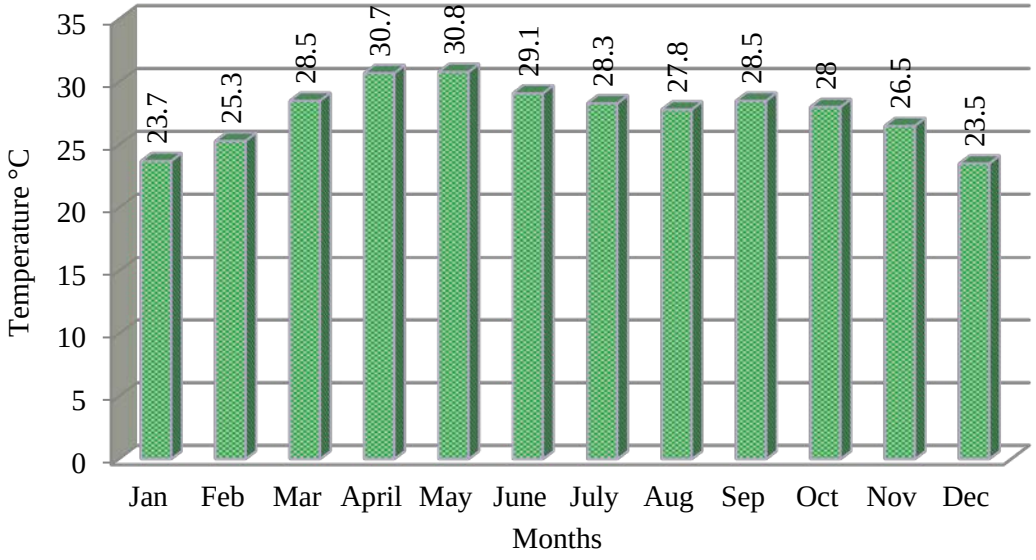

Figure 3.7 Average temperatures in Tatkone Township, 2016
Source: DOA, Tatkone, 2016

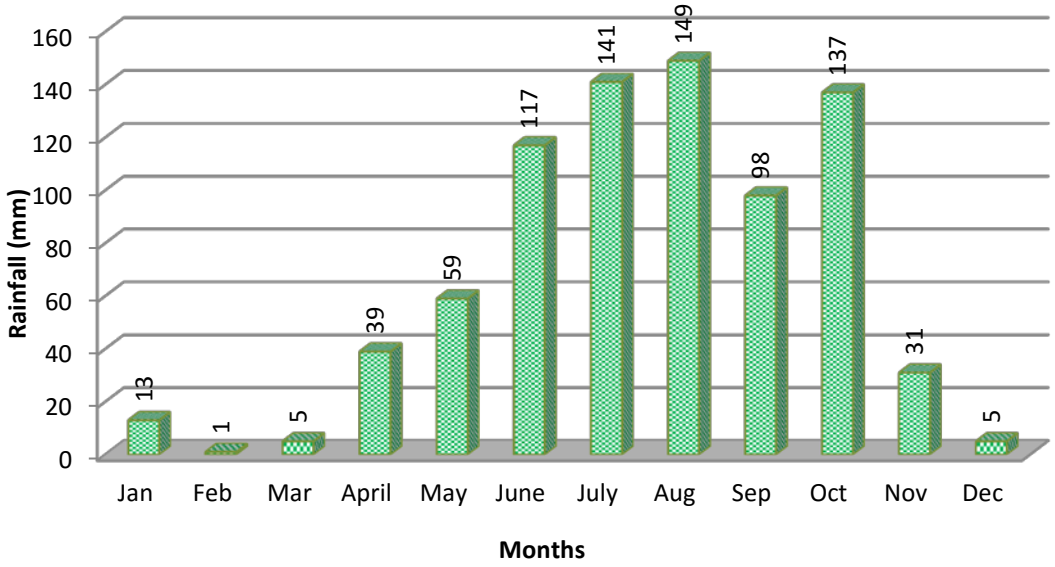

Figure 3.8 Average rainfalls in Tatkone Township, 2016
Source: DOA, Tatkone, 2016

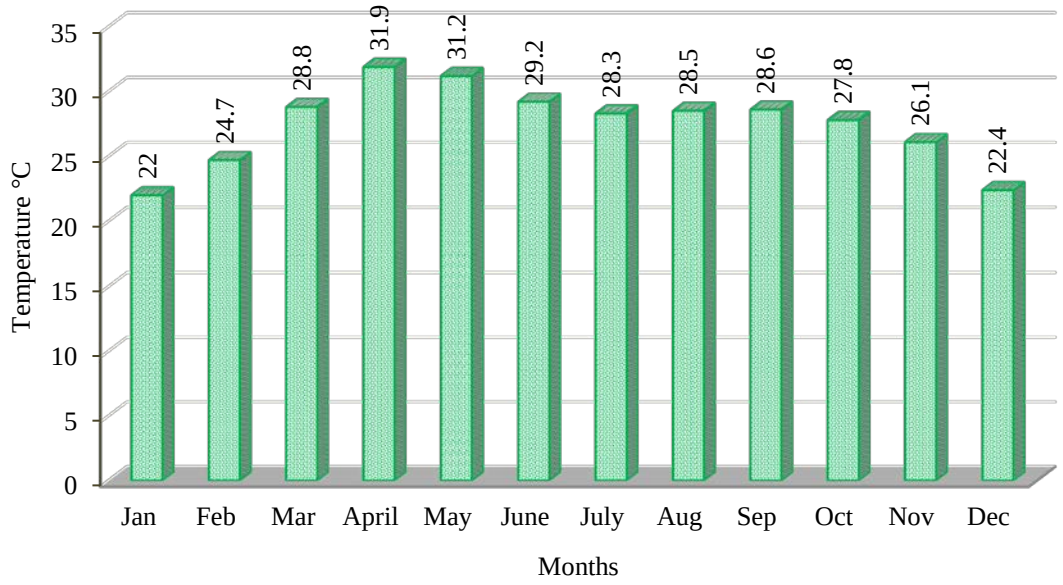

Figure 3.9 Average temperatures in Magway Township, 2016

Source: DOA, Magway, 2016

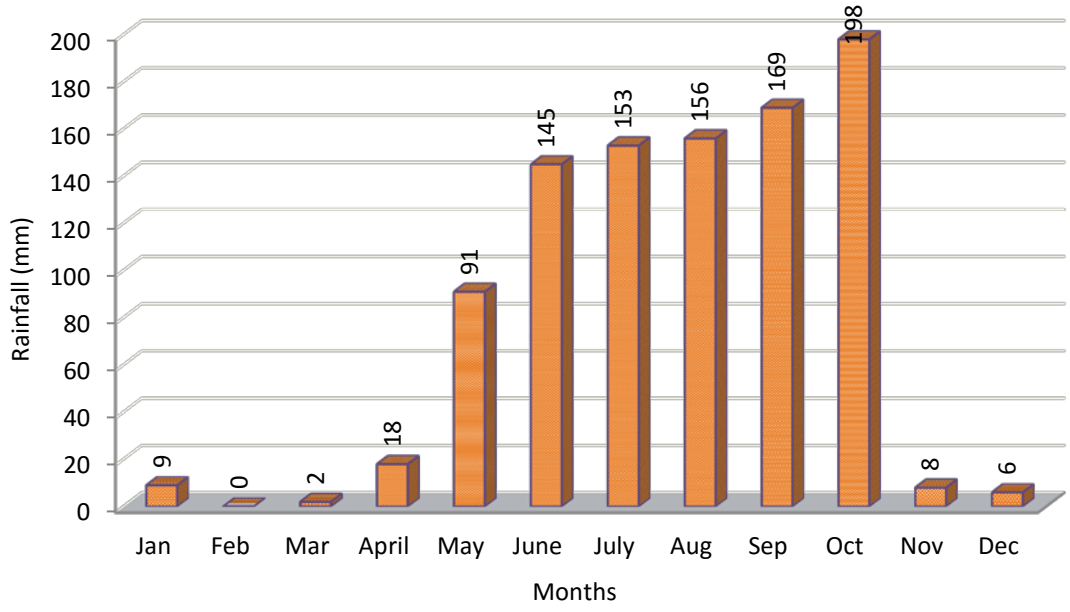

Figure 3.10 Average rainfalls in Magway Township, 2016

Source: DOA, Magway, 2016

3.4 Land Utilization of Study Area

3.4.1 Land utilization in the study areas of southern Shan State

In Southern Shan State, total land area was over 560,000 hectares. Cultivated land was estimated at 57,000 hectares (10.18 percent of total area) and the remaining consists of forests, wild land and cultivated waste land area (DOA Taunggyi 2013).

In Pindaya Township, total area was 62,336.8 hectares and 51.8% of total area was cultivated land area. Cultivated waste land was 15.9% of total area and reserved forest was only 5% of total area. However, wild land area was about 1% and others area was 26.7% in Pindaya Township, Southern Shan State (Figure 3.11).

In Nyaung Shwe Township, the total area was 152,415.4 hectares. Among them, reserved forest area was about 56% of total land area. Cultivated land area was 17.5% of total area and the wild land area is about 5.5%. Others area was 21% of total area in Nyaung Shwe Township (Figure 3.12).

According to land utilization in Hsihseng Township, the total area was 204,136.4 hectares. Cultivated land area was 15.8% of total area and the cultivated waste land was about 44%. Reserved forest was about 29.2% of total land area. Others area was 11% in Hsihseng Township (Figure 3.13).

3.4.2 Land utilization in the study areas of Central Myanmar

The land used in crop productions by farm households in Yamethin Township in Central Myanmar (Figure 3.14). The total land area of Yamethin Township was over 216,900 hectares and agricultural land occupied the largest share of 35% of the total area. Approximately 13% of the total area was reserved forest and 18% was unreserved forest land area. Cultivable waste land area was 2% of total area and 32% of total area was fallow land area.

In Tatkone Township, total land area was over 180, 300 hectares and agricultural land occupied about 25% of total area. Reserved forests area occupied the largest share of 40% of total area and other land area was 33%. Cultivable waste land area was 2% of the total area (Figure 3.15).

In Magway Township, total land area was over 176, 800 hectares. Agricultural land area occupied the amount of 45% of total area and others area was 53% of total area. The rest area was 1% for reserved forests and 1% for uncultivated land area (Figure 3.16).

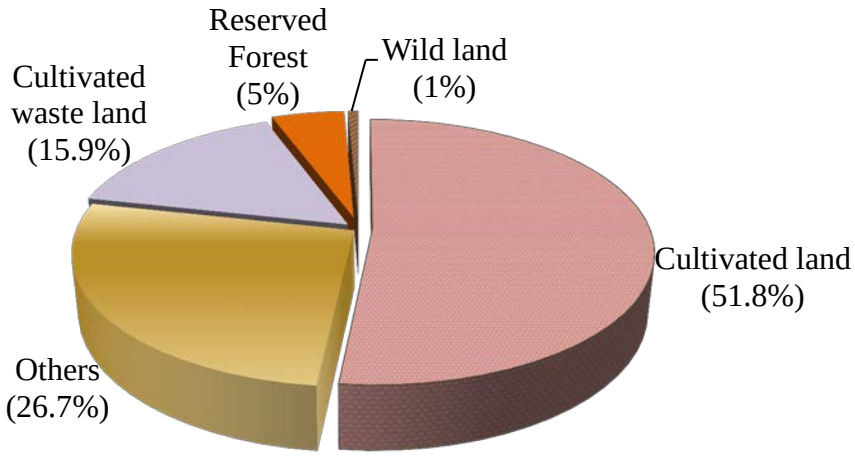

Figure 3.11 Land utilization in Pindaya Township, Southern Shan State, 2013

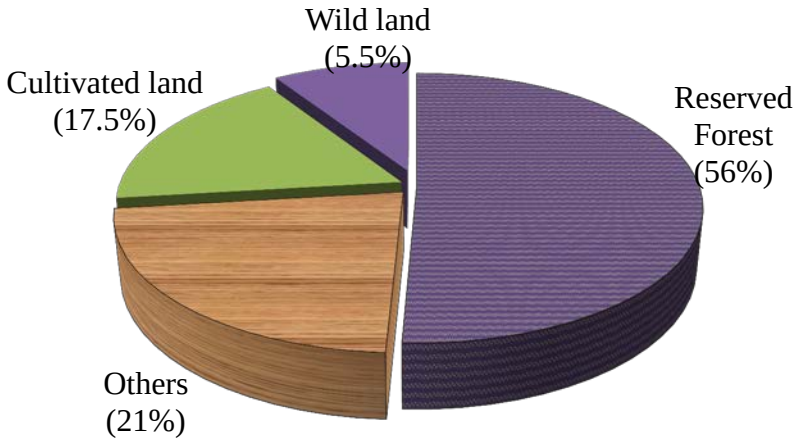

Figure 3.12 Land utilization in Nyaung Shwe Township, Southern Shan State, 2013

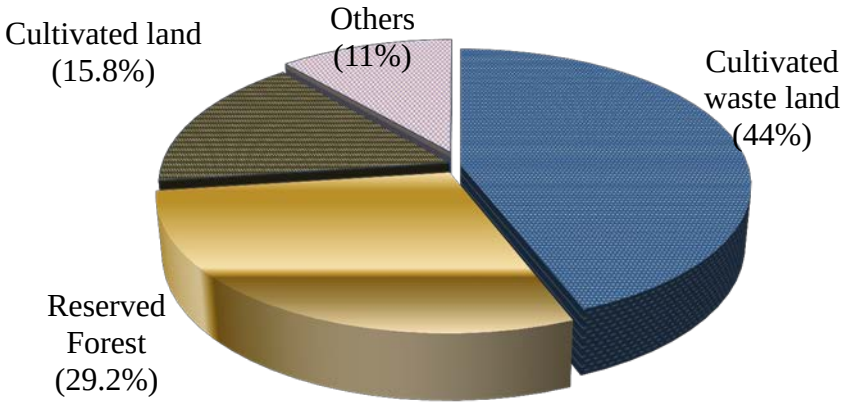

Figure 3.13 Land utilization in Hsihseng Township, Southern Shan State, 2013

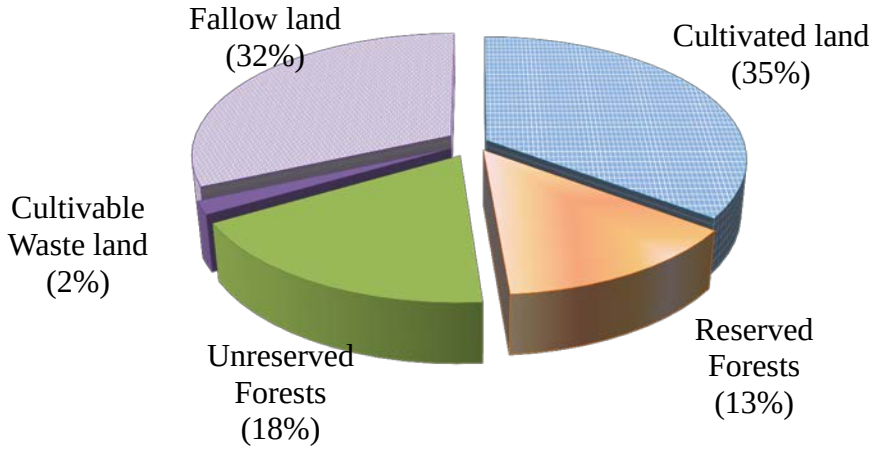

Figure 3.14 Land utilization in Yamethin Township, Central Myanmar, 2016

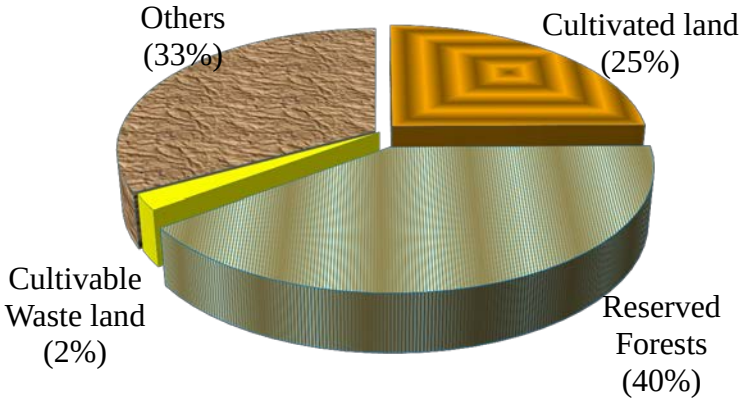

Figure 3.15 Land utilization in Tatkone Township, Central Myanmar, 2016

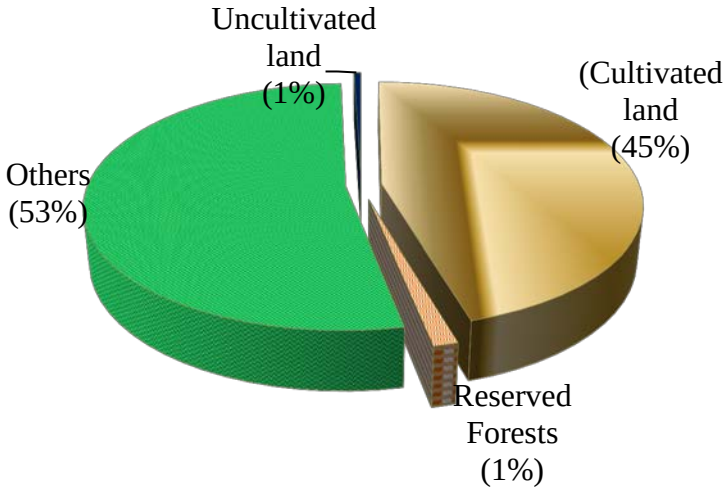

Figure 3.16 Land utilization in Magway Township of Central Myanmar, 2016

3.5 Crop Production of the Study Areas

3.5.1 Crop production in the study areas of southern Shan State

Selected upland areas are almost rainfed and some farmers use “stream flow” to irrigate for their crops. If the amount of rainfall and distribution are favourable, then the farmers involve increasing their crop productivity.

In Pindaya area, there are many cropping patterns such as upland rice-garlic, maize as mono cropping, maize and pigeon pea in intercropping, maize-garlic or mustard, and groundnut-mustard. However, wheat and rentil are cultivated as crop rotation. Mustard is grown as double cropping in Pindaya, although tomato and ginger are grown as a year- round crop.

The results of Hsihseng area indicated that there were five existing cropping patterns in crop year in 2013. Cropping patterns practicing in rain-fed low land area composed to monsoon paddy-fallow. In upland area, maize-chickpea as intercropping, maize-pigeon peas as mixed cropping, upland rice-garlic cropping and vegetables- vegetables cropping in whole year were cultivated. But in the upland area, the main cropping pattern was intercropping of maize and pigeon pea in the early monsoon season that after harvesting of maize, chickpeas were grown. Other farmers practiced upland rice in the early monsoon season followed by garlic or oilseeds.

In Pindaya Township, the various crops such as rice, mustard, niger, pulses, maize, ginger etc. were cultivated (Table 3.1). The sown area of paddy was 28.3% of total area, 22.3% in oilseeds crop and that of perennial crops was 14.2% of total sown area. Moreover, farm households in Pindaya Township cultivated 8.4% of maize total sown area and 7.2% in vegetables. Sown area of potato was 5.9% and 5.6% in wheat. In addition, 5% in pulses, 2.8% in culinary crops and 0.5% in industrial crops were of total sown hectare. In addition, perennial crops such as green tea leaf, orange, and so on.

In Nyaung Shwe Township, paddy, oilseed crops, pulses, maize, and sugarcane as industrial crop were cultivated. Sown area of paddy was 30.1% of total sown area and 11.3% in oilseed crops. Vegetables sown area was 15.5% and sown area of culinary crops and industrial crop were13.1% and 11.1%. In addition, sown area of pulses was 9.3% of total sown area and 5.1% in maize. Furthermore, wheat was cultivated 0.5% of total sown area and 4.0% was grown as forage crops in Nyaung Shwe Township (Table 3.1).

In Hsihseng Township, paddy, oilseed crops, pulses, maize and industrial crops were cultivated. Sown area of paddy was 66.1% of total sown area and 14.7%, 11.2%, 7.1% and 0.9% in maize, oilseeds crops, pulses and industrial crops, respectively (Table 3.1).

3.5.2 Crop production in the study areas of Central Myanmar

Yamethin Township in Mandalay region favors for growing various crops such as rice, pulses, oilseeds, maize and vegetables under either rain fed or irrigated condition.

Cropping patterns in Yamethin Township are rice-rice, sunflower-rice-chickpea, rice-sunflower, green gram-rice and chickpea alone. According to DOA (2015-16), in Yamethin township, area sharing of rice was about one and half times lower than pulses and oilseed crops while vegetables is only about one fourth of rice in term of area sharing percent. Area sharing of non-rice crop such as vegetables was still lower as compared to pulses and oilseed crops in YamethinTownship. In Yamethin, although farmers have changed in practicing crop diversification, some farmers are still continuing their mono cropping practices.

The various crops were sown by farm households in the study area of Central Myanmar (Table 3.2). In Yamethin Township, the total cultivated crop was 106,334.4 hectares in 2015-16 growing season. Among them, pulses were cultivated about 34,620.6 hectares (32.6% of total sown area) and oilseed crops was 30,695.1 hectares (28.8%). Paddy was cultivated about 15,848.6 hectares (14.9%). Chili was sown 13885 hectares (13.1%) and vegetable was sown about 8,617.8 hectares (8.1%). Cotton as industrial crop was sown about 2,198.4 hectares (2.1%). Furthermore, maize and other crops were cultivated about 255.5 hectares and 230.8 hectares in Yamethin Township.

Tatkone Township produced the largest crop production. Total cultivated area was 81974.9 hectares in growing season in 2016. The cultivated crops in Tatkone Township were 33403.6 hectares in pulses (40.7% of total sown area), 18,964 hectares in paddy (23.1%) and 17997.2 hectares in oilseed crops (22%). In addition, maize was cultivated about 2, 173.7 hectares (2.7%) and 1,306.1 hectares (1.6%) of vegetables in Tatkone Township. Moreover, onion, chili and cotton were cultivated about 493.1 hectares, 2,029.6 hectares and 3,646.6 hectares, respectively. The crops were delivered for regional markets to Nay Pyi Taw.

Magway Township is the most productive region and multiple cropping systems are practiced at paddy on farmland. Sesame and groundnut and oilseed were widely sown crops in the largest area. The total cultivable land of Magway Township was 150, 219 hectares in 2015-16. Among these areas, pulses and oilseeds were cultivated 38500.4 hectares (25.6%) and 99614.6 hectares (66.3%). As Magway Region produces a large quantity of groundnut and sesame as edible oil, it is known as the oil pot of Myanmar (Table 3.2).

To increase income of crop production by growing two or more crops, improving the most effective crop diversification becomes immediately necessary today. Therefore, this study provides the key information to investigate the most profitable cropping pattern by farm households in the study areas of Central Myanmar.

Table 3.1 Crop productions in the study areas of Southern Shan State, 2013

Crops	Pindaya		Nyaung Shwe		Hsihseng	
	Hectares	% of total cultivated	Hectares	% of total cultivated	Hectares	% of total cultivated
Paddy	10619.4	28.3	11866.8	30.1	18187.0	66.1
Oilseeds	8381.4	22.3	4438.1	11.3	3091.5	11.2
Perennial crops	5317.4	14.2	0	0	0	0
Maize	3152.2	8.4	1986.6	5.1	4044.9	14.7
Vegetables	2687.0	7.2	6123.9	15.5	0	0
Potato	2210.5	5.9	0	0	0	0
Wheat	2099.2	5.6	184.2	0.5	0	0
Pulses	1876.1	5.0	3657.1	9.3	1947.0	7.1
Culinary	1039.7	2.8	5161.1	13.1	0	0
Industrial crops	170.0	0.5	4372.1	11.1	241.7	0.9
Forage crops	0	0	1580.2	4.0	0	0
Total	37553.0	100	39370.0	100	27512.1	100

Source: DOA (Nyaung Shwe, Hsihseng, Pindaya Township), 2013

Table 3.2 Crop productions in the study areas of Central Myanmar, 2016

Crops	Yamethin		Tatkone		Magway	
	Hectares	% of total cultivated	Hectares	% of total cultivated	Hectares	% of total cultivated
Pulses	34620.6	32.6	33403.6	40.7	38500.4	25.6
Oilseeds	30659.1	28.8	17997.2	22.0	99614.6	66.3
Paddy	15848.6	14.9	18964	23.1	2425.5	1.6
Chilli	13885	13.1	2029.6	2.5	0	0
Maize	255.5	0.2	2173.7	2.7	9678.5	6.4
Cotton	2198.4	2.1	3646.6	4.4	0	0
Vegetables	8617.8	8.1	1306.1	1.6	0	0
Onion	0	0.0	493.1	0.6	0	0
Others	230.8	0.2	1920.6	2.3	0	0
Total	106334.4	100	81974.9	100	150219.0	100

Sources: DOA (Yamethin, Tatkone, Magway), 2016

3.6 Data Collection

The study was based on both primary and secondary data. Primary data was focused on socioeconomic characteristics and income distribution of the sample households. For primary data, the information, including farm labour, family labour-force size, amounts of credits, age of head households, was collected through structured questionnaires. In addition, input costs and output returns, total cultivated areas in each cultivated crop were collected to measure the crop diversification index, profits and labour productivity.

Secondary data was collected from different sources such as Department of Agriculture (DOA) under Ministry of Agriculture, Livestock and Irrigation (MOALI), Food and Agricultural Organization (FAO), Central Statistical Organization (CSO), other related publications and articles in literature.

For the study, the simple random sampling techniques were employed to compute profitability in the crop productions. In the procedure, the sample villages and farm households were randomly selected within existing farming system. Firstly, for Southern Shan State, a simple random technique was used to select fifty (50) farm households in each of township under rainfed conditions. A total of 150 farm households were randomly selected and interviews using structure questionnaires were conducted in 2013 cropping season. Then, for Central Myanmar, a total of 170 farm households were selected and interviewed using structured questionnaires in 2016 cropping season.

3.7 Data Analysis

3.7.1 Conceptual framework

A concept to analysis of farm household responses to economic returns was developed in this chapter. The framework was hinged on the premise that crop diversification was a major concern at micro level. Crop diversification provides the farmers with viable options to grow different crops on the land to maximize the use of land, water and other resources in agricultural development of the nation (Saraswati, Basavaraja and *et.al*.2011).

Crop diversification is largely controlled by both physical and socio-economic conditions of a region. In common, the higher the level of agricultural technology become, the lesser the degree of diversification will be (Raju, 2012).

Therefore, crop diversification is essential as a dimension by political, economic and environmental benefits.

The concept of diversification conveyed different meanings to different people at different levels (Chaplin 2000). Within the agricultural enterprise, diversification may be viewed as a process with four stages. Cropping level involves a shift away from monoculture at first stage. At the second stage, the farms have more than one enterprise and many crops were produced potentially and sold at different times of the year. At the third stage, diversification is understood as being mixed farming. Finally, in mixed farming, there is a shift of resources from one crop to a larger mix of crops. The concept of diversification is often taken to mean a shift away from the production of surplus commodities to those which may be expanded. Definition of crop diversification in this study was really based and described at the second stage.

Different measurements in crop diversification economically include Herfindahl index, Ogive index, Simpson index and Entropy Index. However, Herfindahl index was widely used in measuring crop diversification or specialization in the economic literature which is a genuine justification to compare with other outcomes.

The crop diversification considered and assessed by using Herfindahl Index for various level of crop diversification. Therefore, Herfindahl index known as Herfindahl- Hirschman Index (H_I) is used to measure the firms' size in relation to the industry. It squared the shares of a farm's activities and gave particular weight to the farm's principal activities. It meant that a farm's secondary activities are given only a limited weight in calculating the index. This index takes the value of one, when a farm is completely specialized in its primary activity, and should approach zero as number gets large (Culas and Mahendrarajah, 2005). In addition, Herfindahl index (Swades and Shyamal, 2012) is measured the degree of diversity and is calculated as follows;

$$H_I = \sum \{P_i^{th}\}^2$$

Where

Pi = Proportionate area of the i^{th} crop in the total income in Gross Cropped Area

The index ranges between 0 and 1. If the index was zero, there is perfect diversification. In other words, there is perfect specialization when the index value describes one. Therefore, Herfindahl index is the sum of the squares of the acreage/revenue proportion of each crop in total cropped area/revenue (the square of the proportion of individual activities in a portfolio) (Ali and Byerlee, 2002; and Ogundari. 2013 and Jha, Kumar and Mohanty 2009).

The conceptual framework in terms of microeconomic activities and benefits resulted the changing relative factor endowments in agriculture (Figure 3.17). It was indicated as a two-way level of planning, i.e, one is at the farm level and the other is at the regional level as considered in the framework. This study focused the crop diversification at farm level. Farm households can access a range of assets or resources (financial, socio, human, physical and natural capital) which they can use to engage in farm or non-farm activities or both (Scoones, 1998). Resource endowments consist of land (soils) capability, slope and rainfall patterns, physical cropping suitability and technologies which are supplies of a production alternative.

Therefore, this study would be likely to maximize return per unit area as potential economic crops in agricultural production and would be affected the relative competitive markets of different production systems in future.

3.7.2 Analytical framework

A typical farm system was illustrated the structural interrelationships between various components of a smallholding in which consists of the variety of natural resources available to farm families. Farming enterprises include crop, livestock, poultry, fish, etc. Farm as a unit is considered and planned to be effective combination of the enterprises by combining in each crop production activity. The resources normally include different types of land, various water sources and other resources such as human, social and financial capital. On the other hand, integration of farm enterprises depends on many factors such as:

1. Availability of the resources, land, labour and capital,
2. Present level of utilization of resources,
3. Economics of proposed integrated cropping patterns and
4. Managerial skill of farmer.

Profitability analysis, therefore, was measured by net farm income and return to labour, management per unit area. Next, various activities in enterprise were

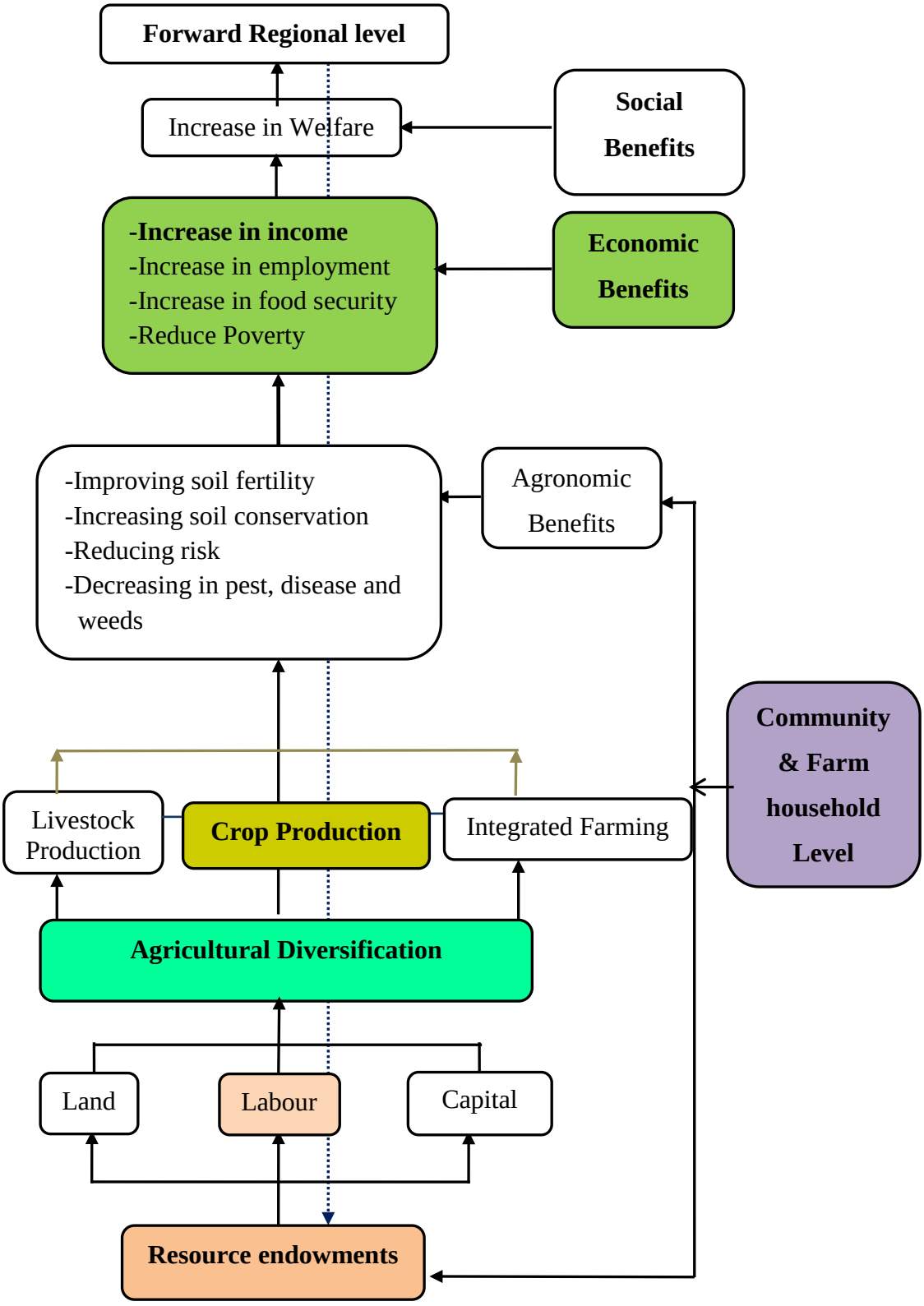

Figure 3.17 Conceptual Frameworks of Agricultural Diversification
Source: http//www.google.com/image/agriculturaldiversification

measured related to efficient use of labour and capital. To assess the effectiveness of economic crops, enterprise budgets were used to estimate costs, returns and profits per unit area in the farm-planning process (Figure 3.18).

The number of units of each enterprise was multiplied to get a first estimate of total gross income and variable costs per unit. And then, other farm income was combined. Next, fixed costs and additional variable costs were continued to estimate net farm income. Gross margin analysis, thus, was used to compare the profitability of crop production practiced by diversified farm households. Gross margin represents the amount of each unit for an enterprise contributed toward profits after the variable costs of production had been paid. Gross margin per hectare, thus, is expressed as:

$$GM = GR - TVC$$

Where,

GM = Gross Margin

GR = Gross Revenue

TVC = Total Variable Cost

Moreover, agricultural productivity in economics was measured as output per unit of land area. Agricultural productivity contains all the factors of production such as labour, farming experience, fertilizers, availability and management of water and other biological factors. The improvement in agricultural productivity is generally considered to be the results of a more efficient use of the factors of productions. Therefore, agricultural productivity was defined as the ratio of local agricultural output to total input used in farm production. On the other hand, it refers the arable land or cultivable land unit (Dharmasiri 2009). Labour input in agriculture is an important parameter of determining productivities of labour and labour use efficiency is expressed returns per family labourday as indicator. Capital is a vital component for determining productivity of land. Therefore, labour efficiency in crop productions refers to the amount of production work completed per man on the farm per unit to time. If labour is efficient, crop productions would be profitable one. Next, the labour use efficiency was estimated for different crop productions during the growing period in 2016. Human factor is one of characteristic distinguishing labour from other resources in agriculture.

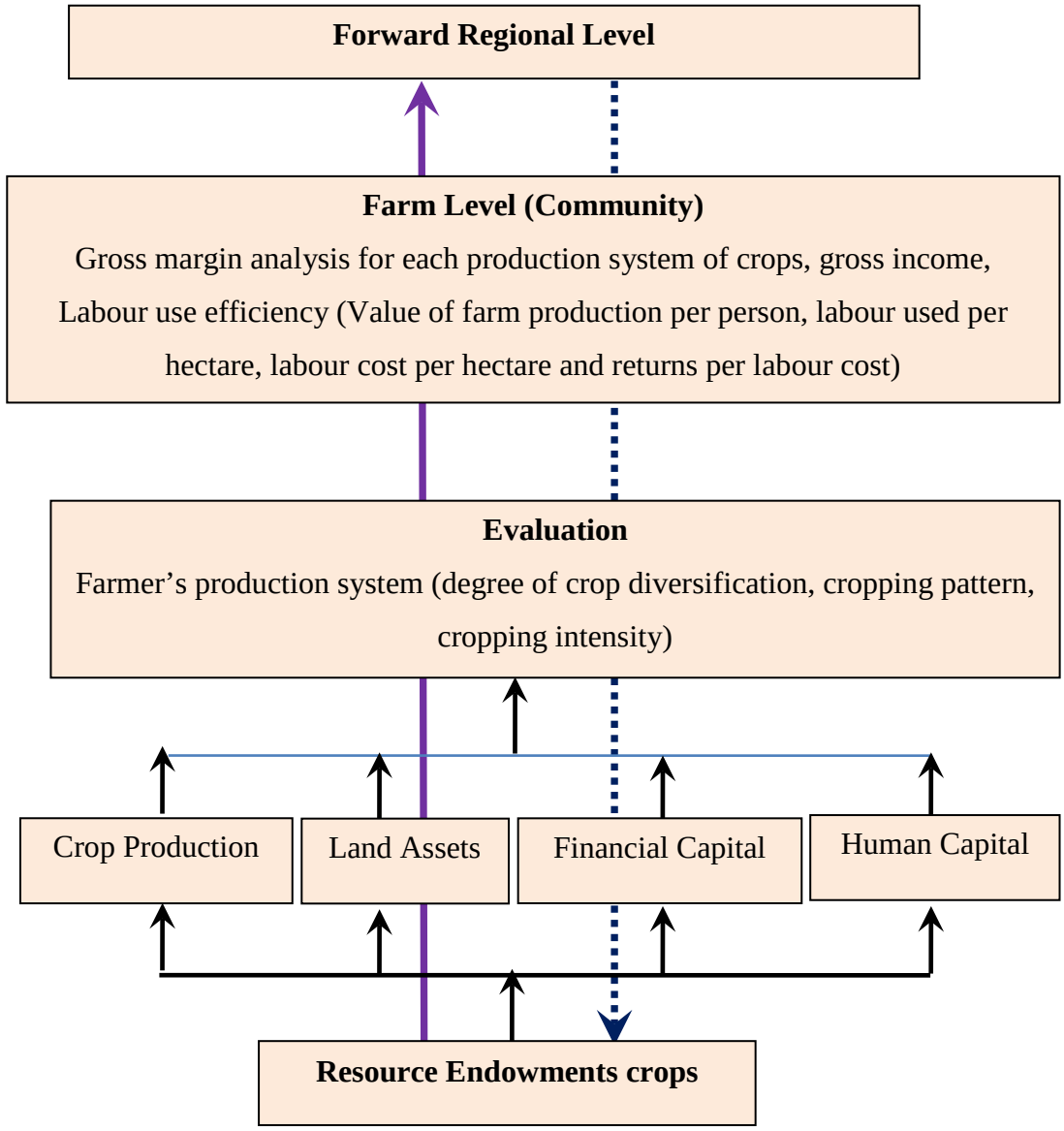

Figure 3.18 Analytical Frameworks for Agricultural Diversification

The total income earned by labour from agriculture or the total number of days that a labour worked in agriculture are based on the kind of laborers such as a farmer's own labour, family labour and hired labour. Human labour is needed in the operations like preparation in cultivation, sowing, fertilizer application, weeding intercultivation, plant protection, harvesting, threshing, etc. (Subba and Reddy *et.al*. 2004). In comparison with other farms, productivity improvement was more efficient use of the labour (Latruffe 2010). In agriculture, labour productivity and skill level have increased even more rapidly to assess both quantity and quality of labour needed for the most profitable combination of labour and capital for the farm community. Therefore, the measurements of labour use efficiency for farm households are important in the crop production system as following,

(a) Crop return per labour in a year is measured the productivity of labour input and calculated by dividing the number of farm products' value under crop area by labour in year.

(b) Gross income per labour is calculated by dividing gross income obtained on the farm by man equivalent year.

(c) Productive return per labour cost equivalent year is calculated the work done on the farm by the worker in a day of 8 hours known as productive man work unit as man-day (Kay and Edwards, 1994).

3.7.3 Econometric Analysis

Descriptive statistics were used to analyze the socioeconomics characteristics of the sample farm households in order to present summary description of the collected data. The tools of analysis involved the use of measures of central tendency such as mean, percentage and measures of dispersion like standard deviation using Microsoft Excel and Statistical Package for Social Science (SPSS).

An economic model with more than one explanatory variable is corresponded as multiple regressions which dependent variable Y is related to two or more independent variables (Anderson, Sweeney and Williams 1999).Therefore, to estimate the factors related with crop diversification by the sampled farm households, the multiple regression model was used. The variables used in the model, their explanation and the expectations were provided. Therefore, the following type of model was used in equation (1) for this study.

$$Y= \alpha +\beta_1 X_1+\beta_2 X_2+\ldots\ldots\ldots\ldots+\beta_n X_n \text{ ----- (1)}$$

Where,

Y = Crop diversification index of farm households

X_1 to X_n = Independent variables

Average value crop diversification index under different crops was estimated by fitting regressions of the type $Y = \alpha+\beta X_t$ (Y= Average value of crop diversification and t was the time within growing season). Here, α and β were the parameters of the model. The equations were fitted by the ordinary least squares OLS method for the growing season of farm families.

The economic model (equation 1) describes the expected value. Random error term (μ) adds to allow for a difference between observed variables and the expected value. On other words, this random error term represents all the factors to differ from the expected value. Therefore, the following model was specified;

$$Y=\beta_0+\beta X_1+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\ldots\ldots\ldots\ldots+\beta_n X_n+\mu\ldots\ldots\ldots\ldots \text{ (2)}$$

It is assumed that for a given observation, the error term (μ) is a random variable with a probability distribution that is normal with a mean of zero and a constant standard deviation in equation (2). In equation (2), the statistical model provides a more realistic description of the relationship between the variables, as well as a framework to develop and to assess estimation of the unknown parameters.

3.8 Empirical Analysis

There are many factors which affect the crop diversification and were grouped into demographic conditions (dimension) and economic conditions (dimension). Data are organized into key and supported indicators to best describe each condition and were transformed into an index of crop diversification. The indices represented the conditions correlated to the demographic and economic dimension with a coefficient that would be the best description to each condition in crop diversifying farming. Since the indices were represented in two dimensions with crop diversification. Crop diversification would provide a picture of the economic and demographic situation in the country.

3.8.1 Measurement of crop diversification

The study used Herfindahl index among the different methods to measure the crop diversification as various concentration indices to work out crop diversification. This index was applied to capture the degree of crop diversification or specialization in agricultural production (Rahman, S. 2009, and Bru¨mmer, and Lu, W. 2006). A detailed description of the Herfindahl index (Ogundari, 2013) in the study is described as follow;

$$H_d = \sum_{j-1}^{j} \left(\frac{Y_j}{\sum_{j=1}^{j} Y_j} \right)^2 \qquad 0 \leq H_d \leq 1$$

Where *Yj* represents the revenue share occupied by the j^{th} crop in total revenue *Y*. *J* is the total number of crops, i.e, when maximum diversification occurs. If the index was zero, it means complete diversification or high diversification. In contrast, if the index was one, it means complete specialization or low diversification (i.e. just one crop).

Then, the degree of diversification was measured by using Herfindahl Index, equal to the sum of the shares across each possible income source. This is the simplest index in which counted the numbers of activities the farm operates. If the farm has no activity, H_d would assign the value of zero. However, when the farm 'n' activities, (say i=1, 2,.., n) then, H_d would assign the value of one for each of those 'n' activities. Thus, value of H_d decreases for increasing diversification.

In addition, the level of crop diversification depends on the geo-climatic or socio-economic conditions and technological development in the study regions. Therefore, it presented regional distribution of patterns of crop diversification grouped into two categories: i) High diversification (index 0.01-0.49) and ii) Low diversification (index 0.5- 1.0 in crop income).

3.8.2 Measurement of gross margin analysis

Crop diversification at farm level was studied in terms of enterprise income and acreage under crops, and resources use of farm households. Resource variation based on acreage explains only diversification of crops, whereas enterprise diversification involves all enterprises between cropping patterns.

The entire cropping pattern was considered because interactions commonly exist between crops in a cropping pattern. Enterprise budgeting (gross margin

analysis) was used to compare the profitability of the most common cropping patterns and practices followed by farm households in the study areas. Then, the return above variable costs (RAVCs) and rate of returns to labour (scarce factor) was compared. All the variable costs included labour, material inputs, interest or capital costs were considered in gross margin analysis.

Gross revenue (Gross benefit) is the level of production per hectare multiplied by the product price. Total variable cost (TVC) is the total of all variable inputs into the enterprise and multiplied by their respective prices. Therefore, enterprise budgeting is used to assess the economic viability of new cropping patterns.

The economic and technical performance of individual farm activities was evaluated in the degree of crop diversification. Thus, enterprise budgets were constructed for production process within the selected regions. Because profitability is obviously related not only to costs of production but also to revenue as the difference between revenue and costs called gross margin analysis. In other words, enterprise budgets enable the technical and economic efficiency of a farmers' existing crop productions to be evaluated and to compare the profitability of enterprise within a farm or between farms.

Firstly, the gross benefit derived from an activity was computed by multiplying the product of yield and price all products of value resulting from the production process. Then, costs of variable inputs, cost of labour inputs included both family and hired labour, cost of capital and materials costs were calculated in the micro soft excel sheets. Finally, net benefit (return per unit of land), return per unit of capital (benefit cost ratio) and return per unit of labour were computed to measure the profitability of crop activities.

Secondly, Gross margin analysis was calculated to estimate costs, revenues and profit per unit area of different crop productions as follow;

Gross Benefit (MMK/ha)	=	Yield * Price of crop
Gross margin (MMK/ha)	=	Total gross benefit – Total variable cost
Total Variable Cost (MMK/ha)	=	Material cost (Cash /Non-cash)+Labour cost (Cash /Non-cash) + Power cost (Cash/Non-cash) + Interest on cash cost

Total Variable Cash Cost (MMK/ha) = Material cash cost + Hired labour cost+ Power cash cost + Internet on cash cost

$$\text{Benefit Cost Ratio(BCR)} = \frac{\text{Gross benefit}}{\text{Total Variable Cost}}$$

Return Above Variable Cost (MMK/ha) = Gross Benefit – Total Variable Cost

Return Above Variable Cash Cost (MMK/ha) = Gross Benefit – Total Variable Cash Cost

3.8.3 Measurement of labour use efficiency

Economics of labour use is an important principle in labour use throughout the year. Labour efficiency depends not only on the skill and training of the labour used but also on the size of the farm enterprise and many other factors (Kay and Edwards, 1986). The unit labour costs (ULC) indicator is considered as one of the best complementary indicators on an economy in evaluating the economic development of nation. This indicator gives the overall picture of the quality of economic growth.

According to objective of the study, labour efficiency was measured to compare and evaluate on farm activities in the same size and cost or total income into a value per person-year as following; computing labour resource used efficiency was compared to economic benefits of diversified farm groups. Labour use efficiency, therefore, depends not only on the skills and training of the labour used but also on the size of enterprise, degree of mechanization, type of organization and other factors (Kay and Edwards 1994).

In other word, the profitability of the farm activities is influenced by the efficiency of the labour resource. Consequently, labour efficiency was measured to compare and evaluate on farm of approximately the same size and type by converting some physical, cost or income into a value per person-year. Therefore, value of Farm Production per person was measured labour efficiency in which total value of agricultural products produced on the farm per person-year. Labour use efficiency was computed for major crop productions as following formula.

$$\text{Return per labour (MMK/md)} = \frac{\text{Total value of Agricultural Products}}{\text{Total Labour Used (maydays)}}$$

$$\text{Return per Labour Cost} = \frac{\text{Total Value of Agricultural Products}}{\text{Total Labour Cost}}$$

(Kay and Edwards 1994)

3.8.4 Multiple regression analysis

The multiple regression analysis estimates the unknown parameters, $\beta_0$to β_n which indicate a change in one of the independent variable affects the values on the dependent variable. Normally two methods are used to estimate these parameters: the ordinary least square method (OLS) and the maximum likelihood estimate. The OLS procedure minimizes the sum of squared differences between the actual Y and the estimated Y. The estimation is carried out by means of a linear relationship and the given residuals are the difference between the actual and the estimated Y. This can be formulated by

$$Y_i=\beta_0+ \beta_1X_1+\beta_2X_2 + \beta_3X_3+ \ldots\ldots\ldots\ldots+\beta_nX_n +U \qquad (1)$$

Where is the estimated value of y_i

$$y_i=\beta_0+ \beta_1x_1+\beta_2x_2 + \beta_3x_3+ \ldots\ldots\ldots\ldots+\beta_nx_n +u \qquad (2)$$

$$u_i = Y_i- y_i \qquad (3)$$

It shows that u_i is simply the difference between the actual and the estimated Y_i . With the least square criterion:

$$\sum u_i^2 = \sum (Y_i-y_i)^2 \qquad (4)$$

Therefore, it might be said that

$$\sum u_i^2 = f\ (\beta_i - \beta_n)^2 \qquad (5)$$

Ordinary Least Square method chooses $\beta_i \ldots\ldots\ldots\beta_n$ for a given sample or set of data, the sum of squared residuals is as small as possible. The obtained estimators are known as the Least Square Estimators. The estimators have to be unbiased, linear, and the variance between the real and the estimated β as small as possible. In the study, the OLS is used to estimate the parameters of the regression model. A linear regression model can be formulated in terms of transformed

variables and the appropriate analysis can be based on the transformed data (Johnson and Bhattacharryya 2001).

In order to evaluate the crop diversification index, value on farm income of diversified farm households, OLS analysis was used. In the linear regression model, the dependent variable is assumed to be a linear function of one or more independent variables. The model is characterized as non-stochastic if one corresponding value for each value of the variable *x* can be identified.

$$y_i=\beta_0+\beta_1 x_1+\beta_2 x_2+\beta_3 x_3+\ldots\ldots\ldots+\beta_n x_n+u \qquad (6)$$

Where,

Yi = dependent variable and $x_2 \ldots x_n$ = a set of independent variables

According to the objective of the study, econometric method using multiple regression models was determined to analyze the factors influencing on crop diversification index of farm households in their crop production process.

The following multiple models were considered for the estimation where all the dependent variables are defined over the total crop income in crop diversified farming. Therefore, multiple regression models were specified in their explicit form as follows:

$$Y=\beta_0+\beta_1 X_1+\beta_2 X_2+\beta_3 X_3+\beta_4 X_4+\beta_5 X_5+\beta_6 X_6+\beta_7 X_7+\beta_8 X_8+\beta_9 X_9+\mu$$

Where,

Y	=	Crop Diversification Index of farm households on their income
β_0	=	Constant
β_1 *to* β_8	=	Regression estimated coefficients
X_1	=	Farm size (hectares)
X_2	=	Amount of credit (MMK/ha)
X_3	=	Schooling years of household heads
X_4	=	Farming experience (years)
X_5	=	Dependency ratio (%)
X_6	=	Numbers of crops
X_7	=	Non-farm income (MMK/ha)
μ	=	error term

In the model, dependent variables were crop diversified index (CDI) of individual household while age of household head, non-farm income, number of crop, average amount of credit and land holding size were used as predictors. Multiple regression models were run by using SPSS version 17.

CHAPTER IV
RESULTS AND DISCUSSION IN SOUTHERN SHAN STATE

The objective of the cropping system research was to increase productivity and income for various enterprises in the farm. It addressed the relationship between the individual farm and environment among enterprises. Furthermore, cropping system was management in resource to achieve economic and sustained production to diverse farm households' requirement. In this chapter, the study highlighted the degree of crop diversification in Pindaya, Nyaung Shwe and Sesai Townships in Southern Shan State could widen the gap between rich and poor as well as the gap between urban and rural communities.

4.1 Classification of Households by level of Diversification in the Study Area

In the study area, farm households cultivated various crops (Figure 4.1). Single crop was cultivated by 24% of farm households whereas 36% cultivated double crops which included in the low diversified group (LDG). Twenty percent of farm households cultivated three crops per year in their farm lands which were recognized as the high diversified group (HDG). However, six, seven and eight crops in one year were rarely cultivated by farm households who were ranged from 0.67% to 1.33%, while from 6.67% to 10.67% of farm households cultivated four and five crops, respectively (Figure 4.1).

The classification of households was conducted based on the degree of crop diversification at farm level by the Herfindahl Index method (H_d) as follow.

$$H_d = \sum_{j=1}^{J} \left[\frac{Y_j}{\sum_{j=1}^{J} Y_j} \right]^2 \qquad 0 \leq H_d \leq 1$$

(Ogundari 2013)

Where,

Y_i = Income share occupied by the j^{th} crop in farm income

Y = Farm income of the households

J = Total number of crops

H_d approaches zero with increasing diversification and equals to one when there is complete specialization in a single farming activity.

Sixty percent of total farm households were in the range (0.5 to 1.0) in LDG (LDG) and 40% of total farm households were in the range (0.0 to 0.49) in high diversified farm group (HDG). Average index of low diversified farm households was 0.81 and high diversified farm households were 0.39 (Table 4.1). Above finding illustrated farm households mostly practiced low diversified farming and it is needed to increase cropping intensity in low diversified group (LDG) in agriculture.

4.2 Socioeconomic Characteristics of Sample Farm Households in the Study Area

The socioeconomic characteristics of farm households were illustrated in the level of diversification. Average family size was similar in both groups with 5 members per household in both diversified groups (Table 4.2).

Average age of household heads in LDG was 47.3 years and it was 47.9 years in high diversified farm group. Average farming experience of farm household heads in low diversified group (LDG) was 23.7 years while farm household heads in high diversified group (HDG) was 26.1 years. Therefore, it is observed that farm households in both groups were dependent on farming as a major source of employment.

Average schooling years of low diversified households' head and high diversified households' head were 2.8 years and 3.1 years, respectively. It means that they had the primary education level. Dependency ratio is a measure of portion of a population which is composed of dependent people, who are either too young or too old to work. Dependency ratio was 44% in low diversified groups and 45% in high diversified group. Moreover, 77.7% of low diversified households' head and 83.3% of high diversified households' head were males who worked on farm. Female headed households in low diversified group had 22.3% whereas 16.7% was in high diversified group.

About 76.6% of low diversified farm households heads in primary education were compared to 35% of farm households' head in high diversified group. However, it was found that 35% in higher education, and 30% of the farm households in middle education of high diversified group were higher compared to 5.6% and 17.8% of farm households' heads in low diversified group (Table 4.2).

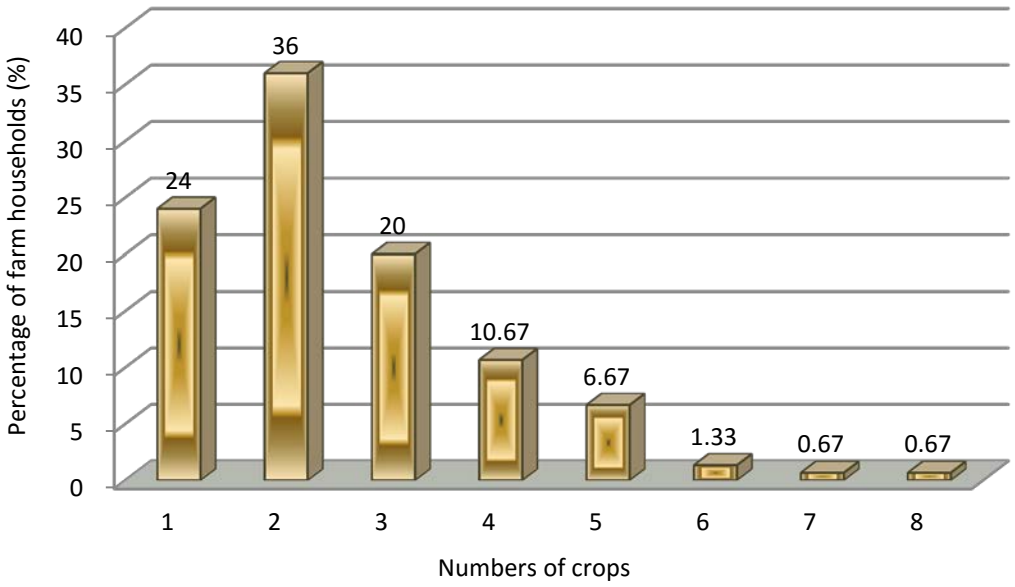

Figure 4.1 Number of crops planted by farm households in southern Shan State

Table 4.1 Classification of farm households by level of diversification in the Southern Shan State , 2013

Categories of Diversification	Index Range	No. of households	Average diversified index
Low Diversification (LDG)	0.5 – 1.0	90 (60)	0.81
High Diversification (HDG)	0.0 – 0.49	60 (40)	0.39
t.test			15.86***

Note: Numbers in parenthesis are percent, *** indicates significant at 1 % level.

Table 4.2 Characteristics of farm households in the Southern Shan State, 2013

Average	LDG (n= 90)		HDG (n= 60)		t-test/Chi-square test
	Avg.	Range	Avg.	Range	
Family size (No.)	5.2	1-11	4.9	2 - 8	0.74^{ns}
Age of household head (years)	47.3	22-70	47.9	21-79	- 0.25 ^{ns}
Farming experience (years)	23.7	3-53	26.1	1- 60	- 1.11 ^{ns}
Schooling years of households' heads	2.8	1-5	3.1	1 - 6	- 1.85**
Primary schooling year (%)	76.6		35.0		
Middle schooling year (%)	17.8		30.0		
Higher schooling year (%)	5.6		35.0		
Dependency ratio (%)	44.0		45.0		^{a}16.72 ^{ns}
Male headed households (%)	77.7		83.3		^{a}4.34**
Female headed households (%)	22.3		16.7		^{a}4.34**

Note: ** and *** indicates significant at 5 % and 1 % level, respectively, ns states non-significant.
a denotes Chi-square test.

4.3 Resource Availability and Use

4.3.1 Farm size of sample households in the study areas of Southern Shan State

Average farm size was 1.9 hectares and it was ranged from 0.2 to 7.7 hectares in low diversified farm households group (Table 4.3). Average farm size of high diversified farm households group was 2.9 hectares in the range of 0.8 and 12.2 hectares. In the low diversified farm households group, 60% of farm households owned land under 2.0 hectares and 45% of high diversified farm households group owned land between 2.01 hectares and 4.0 hectares.

However, 32% of low diversified farm households and 42% of high diversified farm households group owned land between 2.0 hectares and 4.0 hectares. Above 4.01 hectares owned by 8% of low diversified farm households group and 13% of high diversified farm households. Therefore, low diversified farm households who owned small area was higher than high diversified farm households in the study areas.

4.3.2 Crop sown area in the study areas of southern Shan State

Percentage of total cultivated crop areas sown by two diversified groups was revealed in Figure 4.2. Maize was sown on 39.2% of total cultivated areas by low diversified farm households group. Paddy was cultivated 37.3% of total cultivated area and sugarcane was cultivated about 12% in low diversified farm households group. Low diversified farm households group cultivated groundnut (1%) and niger was sown on 2.8% of total sown area. In addition, tomato, mustard and other crops were cultivated 1.7%, 2.1% and 3.9% of total cultivated areas, respectively.

In high diversified farm household group, maize was cultivated on 32% of total sown area in the study areas. About 26.6% of total sown area was cultivated paddy by high diversified farm households group. Nevertheless, high diversified farm households did not produce sugarcane, but groundnut and niger were cultivated on 7.8% and 4.5% of total sown areas. Tomato (8.2%), mustard (6.4%) and other crops (13.1%) were respectively sown by high diversified group.

The average cultivated area of various crops sown by sample diversified farm households in the study areas, southern Shan State was revealed in Table 4.4. In the case of maize, the average sown area of low diversified farm households was 2.94 hectares in the range of 0.41 and 8.10 hectares.

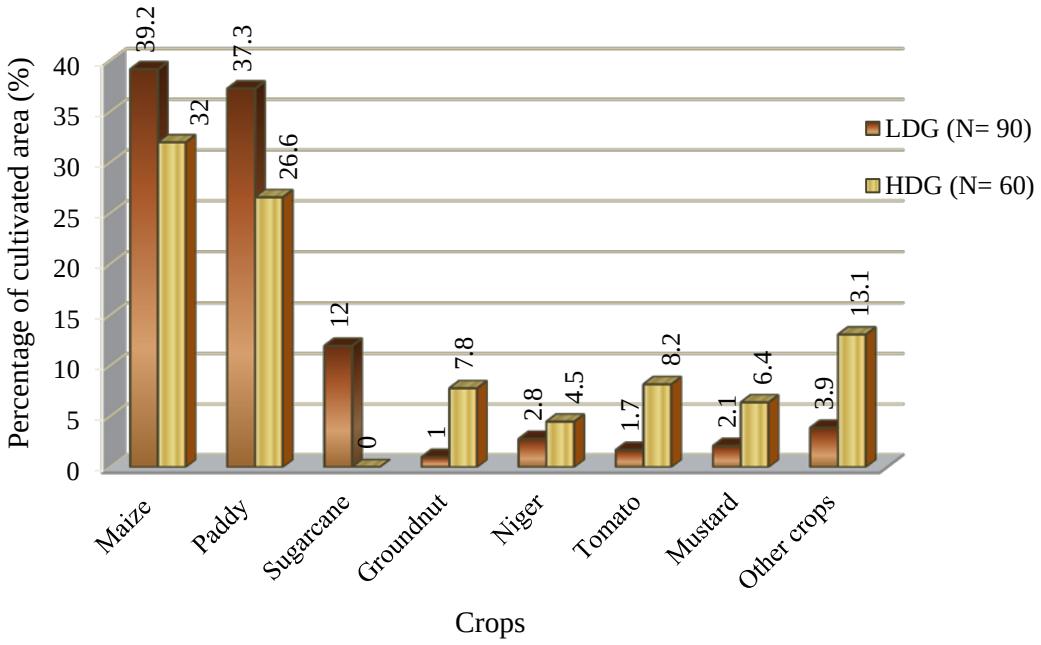

Figure 4.2 Percentage of total cultivated crop areas in the study areas of Southern Shan State, 2013

Table 4.3 Farm size and cultivated land area of sample diversified farm in the study areas of Southern Shan State

Land area (ha)	LDG (N= 90)			HDG (N= 60)			t-test/ Chi-square test
	Avg.	Max.	Min.	Avg.	Max.	Min.	
Farm size	1.9	7.7	0.2	2.9	12.2	0.8	-3.55***
Percentage of farm households owned land							
< 2.0 ha	60.0			45.0			[a] 51.40**
2.01 - 4.0 ha	32.0			42.0			
> 4.01 ha	8.0			13.0			

Note: ** and *** indicates significant at 5% and 1% level. a is denoted Pearson chi-square test.

Table 4.4 Average area sown by sample diversified farms in the study areas of Southern Shan State (hectares)

Crops	LDG(N= 90)			HDG(N= 60)			t - test
	Avg.	Max.	Min.	Avg.	Max.	Min.	
Maize	2.94	8.10	0.41	1.71	10.0	0.41	2.81***
Paddy	1.49	5.10	0.20	1.07	2.47	0.41	1.82**
Sugarcane	0.92	4.10	0.41	0.00	0.0	0.0	3.21***
Groundnut	0.54	0.81	0.41	0.62	1.62	0.41	[ns] - 0.36
Niger	1.62	4.50	0.41	0.81	1.62	0.41	[ns] 1.79
Tomato	0.41	0.41	0.41	0.55	1.01	0.41	-1.98**
Mustard	0.39	0.45	0.21	0.63	2.03	0.4	-2.20**
Other crops	1.15	1.50	0.41	1.10	1.1	0.4	[ns] 0.16

Note: ** and *** stand for significant at 5 % and 1 % level respectively and ns does not stand for significant.

The average sown area of maize was 1.71 hectares in high diversified farm households group. It was statistically and highly significant at 5% level between groups. While the average sown area for paddy was 1.49 hectares in the range of 0.20 and 5.10 hectares in low diversified farm households group, high diversified farm households groups cultivated 1.07 hectares for paddy in the range of 0.41 and 2.47 hectares. It was statistically significant at 5% level between groups. However, low diversified farm households group produced sugarcane (0.92 hectare) and high diversified farm households group did not grow it in the study areas. In addition, groundnut and niger were cultivated 0.54 hectare and 1.62 hectares, respectively, in low diversified farm group on an average although they were not significantly different.

Average sown area of tomato was 0.41 hectare in LDG and 0.55 hectares in HDG and they were statistically significant at 5% level between groups. Average sown areas of mustard were (0.39 hectare) in LDG and 0.63 hectare in HDG were also significant different. Moreover, average sown areas of other crops were 1.15 hectare and 1.10 hectares significantly different at 5% level between groups.

Therefore, maize was the most important crop for both groups because it had the largest sown area in the study areas. Maize cultivation required a critical land area to obtain major income to be viable for additional income. Paddy was considered the second most important crop for home consumption in both groups. However, mustard, groundnut, niger and other crops required more farming activities for high diversified farm households group than low diversified farm households group.

4.4 Crop Production in Southern Shan State

4.4.1 Cropping patterns in the study areas of Southern Shan State

Since production was the most obvious output, the efficiency of the management measured the cropping pattern related to productivity as land, labour, capital and energy (Pearson and Norman 1995). In the study areas of Southern Shan State, there were many cropping patterns such as upland rice, maize, vegetables and sugarcane as mono cropping. Maize and pigeon pea, maize-paddy, maize-oilseed (groundnut/niger), paddy- vegetables such as tomato, mustard, cabbage, garlic etc. were found as inter cropping. Mustard is grown as double cropping in Pindaya. However, tomato and ginger are grown as the year-round crops. In this section,

paddy, maize, sugarcane, oilseeds (groundnut and niger), pigeon pea and vegetables were presented in cropping patterns (Table 4.6).

The results of Hsihseng Township indicated that there were five existing cropping patterns in crop year 2013. Cropping patterns practicing in rain-fed low land area composed of monsoon paddy-fallow. In upland area, maize-chick pea as intercropping, maize and pigeon peas as mixed cropping, upland rice-garlic cropping and vegetables-vegetables cropping were cultivated in whole year. The main cropping pattern was intercropping of maize and pigeon pea in the early monsoon season. Other farmers practiced upland rice in the early monsoon season followed by garlic or oilseeds.

Numbers of sown crops by degree of diversified farm households was indicates in the study areas of southern Shan State (Table 4.5). In Hsihseng Township, 7.7% and 21.1% of low diversified farm households, respectively, cultivated mono cropping and double cropping. However, 23.3% of high diversified farm households cultivated triple cropping and 8.3% of farm households grew multiple cropping.

In Pindaya Township, 3.3% of low diversified farm households cultivated mono cropping and 7.7% of low diversified farm households practiced double cropping, respectively. However, 20% of high farm households group cultivated three crops successively and 16.7% and 21.7% of high diversified farm households cultivated four crops and five crops in a year.

Furthermore, 28.8% and 31.2% of low diversified farm households group cultivated mono cropping and double cropping in Nyaung Shwe Township. Among high diversified farm households in Nyaung Shwe Township, the comparatively small number of farm households cultivated multiple cropping (Table 4.5).

4.4.2 Cropping patterns practiced by diversified sample farm households in the Southern Shan State

According to the results, it was observed that (1) mono crop which consists of rice -fallow (or maize or sugarcane or vegetables-fallow) (2) rice-based cropping patterns and (3) maize-based cropping patterns were practiced by diversified farm households in Hsihseng, Pindaya and Nyaung Shwe Townships.

Table 4.5 Number of crops sown by sample diversified farms households in the study areas of Southern Shan State, 2013

Townships	LDG (n= 90)			HDG (n= 60)			
	Mono	Double	Total No.HH	3 crops	4 crops	More than 4 crops	Total No.HH
Hsihseng	7	19	26	14	5	0	19
	(7.7)	(21.1)	(28.8)	(23.3)	(8.3)	(0)	(31.6)
Pindaya	3	7	10	12	10	13	35
	(3.3)	(7.7)	(11.0)	(20)	(16.7)	(21.7)	(58.4)
Nyaung Shwe	26	28	54	3	2	1	6
	(28.8)	(31.2)	(60.0)	(5.0)	(3.3)	(1.7)	(10.0)
Total	36	54	90	29	17	14	60
	(40.0)	(60.0)	(100)	(48.3)	(28.3)	(23.3)	(100)

Note: Numbers in parenthesis are percent.

Mono cropping pattern was practiced by LDG in the study areas of southern Shan State (Figure 4.3). In Hsihseng Township, paddy was cultivated as a mono crop from May to second week of October. Maize was cultivated as mono crop from May to October. In Pindaya Township, vegetables were cultivated as mono crop from July to December. In Nyaung Shwe Township, paddy was cultivated as mono crop from June to October and sugarcane was grown from June to March. Vegetables were cultivated as mono crop from October to December and some farm households cultivated vegetables from November to January and some cultivated vegetables from January to March.

Double cropping pattern was also practiced by low diversified farm households in Hsihseng and Pindaya Townships (Figure 4.4). In Hsihseng Township, some low diversified farm households cultivated maize together with pigeon pea as mixed crops from May to September for maize and second week of March for pigeon pea crop. Maize-paddy was sown from May to first week of August for maize and from second week of September to December for paddy near water stream. Some cultivated oilseed crops from October to first week of February followed by paddy which was cultivated from end of May to September. In Pindaya Township, some farm households cultivated vegetable (Garlic) was cultivated from the first week of October to March after paddy crop had harvested at the end of September. Vegetables followed by vegetables were cultivated from October to February. Double cropping patterns were practiced by low diversified sample farm households in Nyaung Shwe Township (Figure 4.5). Maize and pigeon pea were cultivated as mixed crops from the beginning of May to September. Maize and pigeon pea were harvested on March. Maize-paddy was cultivated from May to August for maize and from September to December for paddy near the stream water. Some farmers cultivated vegetables followed by paddy were cultivated from mid of October to December. Some cultivated vegetables from January to second week of March and paddy was cultivated from second week of May to September. Oilseeds followed by paddy were cultivated from the mid-October to the mid-February and paddy was cultivated from the mid-May to September. Vegetables followed by vegetables were cultivated from mid of October to March.

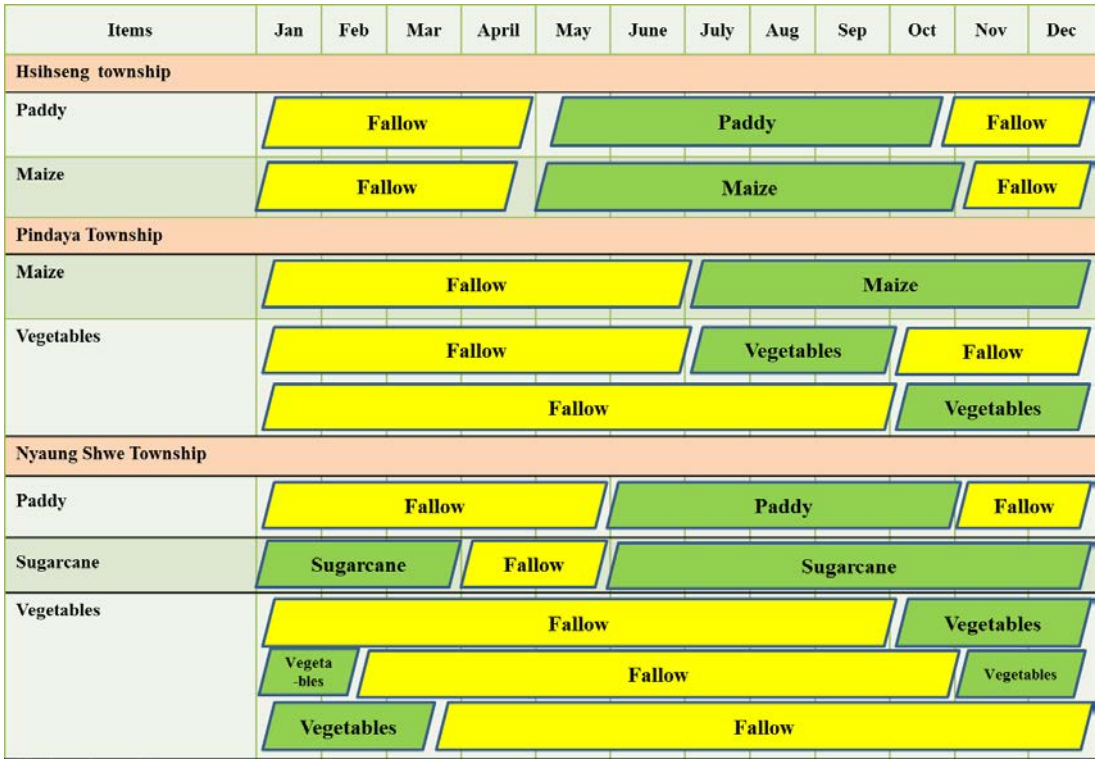

Figure 4.3 Mono cropping patterns practiced by low diversified farm households in Hsihseng, Pindaya and Nyaung Shwe Townships, 2013

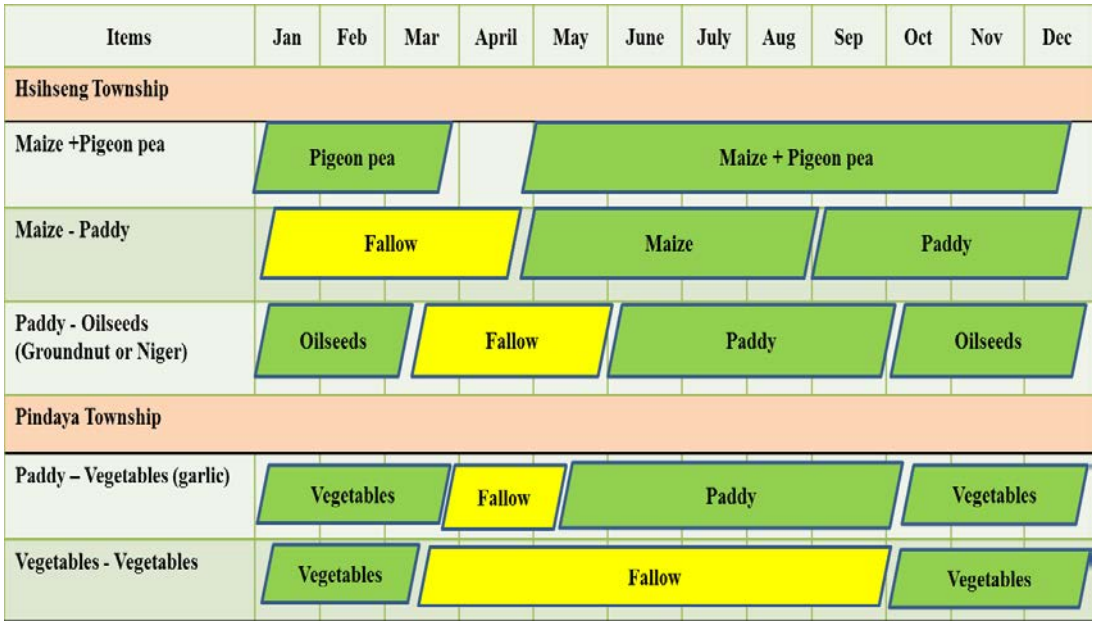

Figure 4.4 Double cropping patterns practiced by low diversified farm households in Hsihseng and Pindaya Townships, 2013

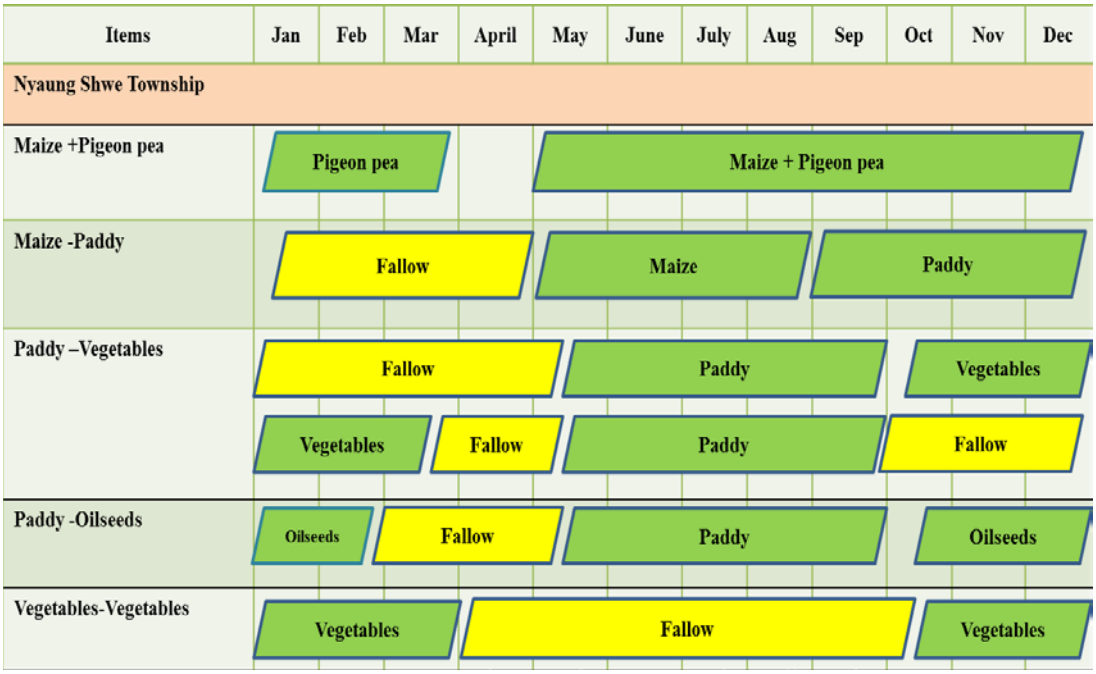

Figure 4.5 Double cropping patterns practiced by low diversified farm households in Nyaung Shwe Township, 2013

Multiple cropping patterns were practiced by HDG in Hsihseng and Nyaung Shwe Townships (Figure 4.6). In Hsihseng Township, paddy was grown from end of May to September and then oilseeds were continued to grow from October to December and then vegetable (garlic) was grown December to May during the growing season. In addition, maize and pigeon pea were cultivated as mixed crops from June to October for maize and June to March for pigeon pea. Oilseeds were sown from the end of October to January after maize had been harvested.

In Nyaung Shwe Township, maize and oilseeds were cultivated as mixed crops from end of May to mid of October and vegetables were cultivated from December to March. Paddy was cultivated from June to first week of October. Then, vegetables followed by oilseeds were sown from mid-October to December and then next vegetables were grown from January to mid-March. Nevertheless, some farmers cultivated vegetables as three crops during growing season.

Multiple cropping patterns practiced by high diversified farm households in the Pindaya Township (Figure 4.7). Paddy was sown from end of June to first week of October. And then, Oilseeds crops were cultivated from the first week of October to January. After paddy and oilseeds had been harvested, vegetables were grown from end of January to March. High diversified farm households cultivated maize from end of May to September. Oilseed crop was cultivated from October to January after maize was harvested and then vegetables were sown from January to March. Some farm households cultivated paddy at the end of May to first week of October. Vegetables was grown during October to December, after complete harvest other crops such as ginger and garlic were grown during January through May. However, some farm households grown vegetables for the whole year.

4.4.3 Land allocation and cultivated crops by diversified farm households

As the study area was mainly in rain-fed area, farm households cultivated various crops to make efficient use of soil moisture the whole year. In LDG, farm households cultivated paddy, maize, sugarcane and vegetables as the single crop in a year. Cropping patterns and allocated sown area by diversified farm household groups in the study areas (Table 4.6).

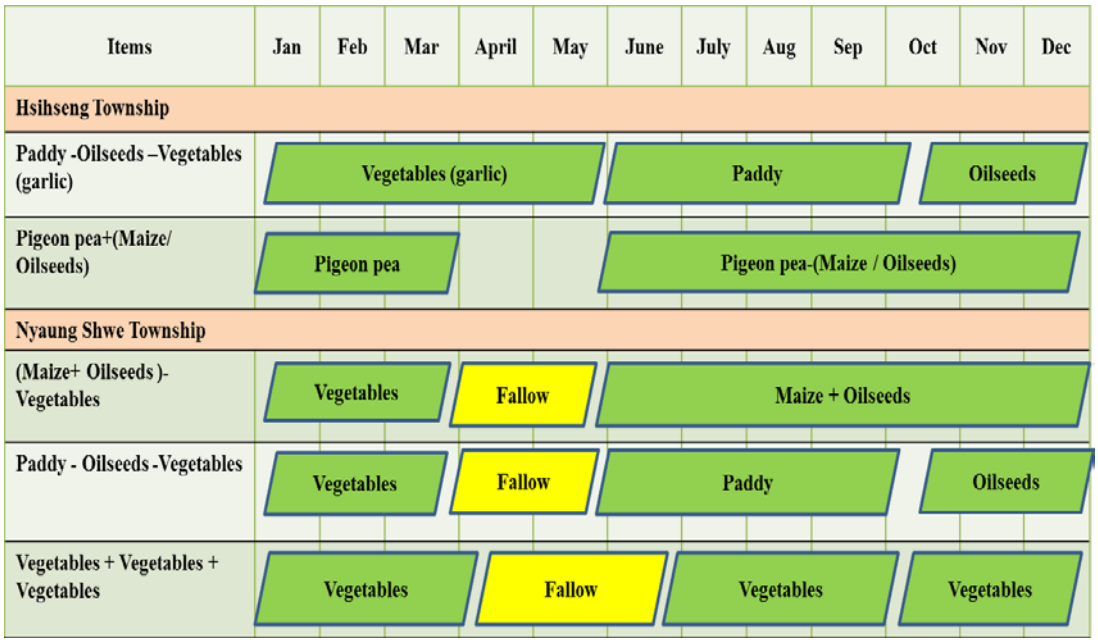

Figure 4.6 Multiple cropping patterns practiced by high diversified farm households in Hsihseng and Nyaung Shwe Townships, 2013

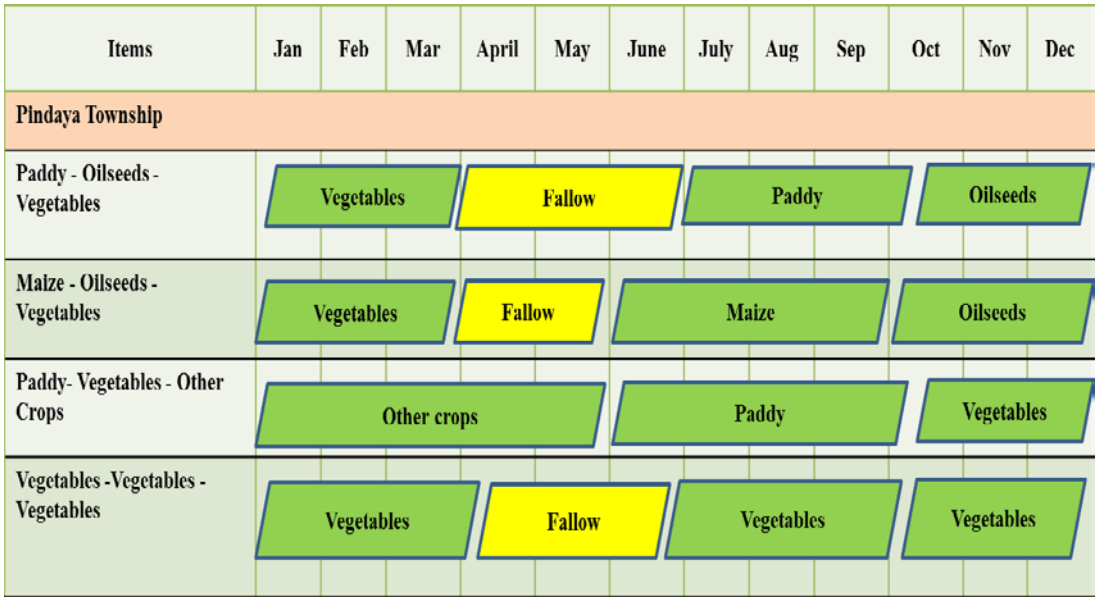

Figure 4.7 Multiple cropping patterns practiced by high diversified farm households in Pindaya Township, 2013

LDG practiced maize-based cropping pattern and paddy-based cropping patterns. Farm households cultivated maize for sale and paddy was cultivated for home consumption. After harvesting the maize and paddy, oilseed crops and vegetables were cultivated as the second crop. Therefore, paddy was the main source of food for farm households and constitutes the basis of the daily diet in both groups.

About 41.7 % of low diversified farm households allocated paddy in Hsihseng Township. On an average area of 0.81 hectare and 4.5% of sown area was allocated to paddy (Table 4.6). Maize was cultivated on an average area, 2.9 hectares, by low diversified farm households and 95.4% of sown area was maize by 16.7% of farm households in the Hsihseng Township.

In Pindaya and Nyaung Shwe Township, 13.8% of low diversified farm households cultivated only vegetables. In the Nyaung Shwe Township, farm households cultivated paddy crop on an average of 2.2 hectares which was 77.3% of cultivated area as a mono crop. About 27.8% of farm households cultivated sugarcane on an average area of 0.80 hectares which occupied 21.6% of the cultivated area. Moreover, vegetables were allocated on an average area of 0.2 hectares which was sown on 1.1% of growing area in low diversified farm households group.

Therefore, although food crops were still important for the farm households, maize became important as a cash crop after paddy in LDG. Farm households cultivated two crops such as maize with pigeon pea, maize-paddy, paddy followed by oilseeds, paddy-vegetables and vegetables-vegetables during the growing season. Maize with pigeon pea was cultivated on 47.4% of cultivated area which was an average acreage of 6.1 hectares in Hsihseng Township. Average acreage of paddy-maize was allocated on an average of 4.4 hectares which was 42.1% of sown area in the Hsihseng Township. On the other hand, 26.0% of low diversified farm households allocated oilseeds followed by paddy on an average area of 1.0 hectares (10.5% of the cultivated area).

However, in Pindaya Township, 48.7% of sown area was allocated vegetables followed by paddy crop on an average of 1.3 hectares. In addition, 30.7% of sown area was allocated on an average acreage of 0.8 hectares of vegetables in the whole year by low diversified group. In Nyaung Shwe Township, maize-paddy was cultivated on 6.4% of sown area in which was allocated on an average 3.2 hectares.

Moreover, vegetables followed by vegetables were allocated 9.2% of sown area on an average acreage of 0.6 hectare.

Multiple cropping patterns practiced by HDG in the study areas of Southern Shan State (Table 4.7). In HDG, the result showed five cropping patterns sown by farm households. Maize was allocated on 2% of sown area on average acreage of 1.6 hectares for maize-oilseeds cropping pattern in Hsihseng Township.

In Pindaya Township, vegetables and other crops followed by paddy allocated on the average area of 2.6 hectares in 11% of cultivated area. Vegetables followed by paddy, maize and oilseeds 31.5% of cultivated area on average area 3.1 hectares. In addition, farm households cultivated vegetables in two seasons 18.7% of cultivated area and allocated on average area was 2.8 hectares.

In Nyaung Shwe Township, high diversified farm households allocated vegetables after oilseeds and paddy on an average acreage of 2.7 hectares in 49.6% of sown areas. Vegetables were sown on 41.7% of cultivated area after cultivating maize and pigeon pea followed by paddy on an average of 3.0 hectares. Vegetables were cultivated on 8.7% of cultivated area on an average of 1.4 hectares.

Therefore, maize was mostly cultivated as a mono crop in low farm households and maize with pigeon pea was also mostly cultivated as mixed crops in Hsihseng Township. In addition, paddy and maize were mostly cultivated in Hsihseng than Pindaya and Nyaung Shwe Townships. Vegetables were cultivated as two season crops per year for low diversified group in Pindaya and Nyaung Shwe Townships. Similarly, high diversified farm households were mostly cultivated vegetables as three season crops in Pindaya and Nyaung Shwe Townships.

4.4.4 Cropping intensity in Southern Shan State

Higher cropping intensity means that a higher proportion of the net sown area is being cropped more than once during one agricultural year. This also implies higher productivity per unit of cultivated land during one year (Sunil Bhaskar 2009).

According to the finding, cropping intensity indices of low diversified farm households were 109% in the range of 100% and 150% intensity. In the high diversified group, average cropping intensity was 133% in the range of 106% to 167% intensity (Table 4.8).

Table 4.6 Land allocations for mono and double cropping patterns practiced by low diversified farm households in the study areas of southern Shan State, 2013

Cropping Patterns	Total No. of HH (N=90)	Townships								
		Hsihseng			Pindaya			Nyaung Shwe		
		No. of HH	Area (ha)	% of growing area	No. of HH	Area (ha)	% of growing area	No. of HH	Ave area (ha)	% of growing area
Paddy	15 (41.7)	1	0.8	4.5	0	0	0	14	2.2	77.3
Maize	6 (16.7)	6	2.9	95.4	0	0	0	0	0	0
Sugarcane	10 (27.8)	0	0	0	0	0	0	10	0.8	21.6
Vegetables	5 (13.8)	0	0	0	3	1.2	100	2	0.2	1.1
Total	36 (100)	7		100			100	26		100
M + Pi	10 (18.5)	9	6.1	47.4	0	0	0	1	2.8	5.6
M- P	10 (18.5)	8	4.4	42.1	1	1.6	20.5	1	3.2	6.4
P - V	10 (18.5)	0	0	0	3	1.3	48.7	7	1.9	26.7
P - O	14 (26.0)	2	1.0	10.5	0	0	0	2	1.6	10.4
V - V	10 (18.5)	0	0	0	3	0.8	30.7	7	0.6	9.2
Total	54 (100)	19		100			100	28		100

Note: Numbers in parenthesis are percent.

P = Paddy, M = Maize, Pi = Pigeon pea, O = Oilseeds, S = Sugarcane, V = Vegetables (Tomato, Mustard, Cabbage, Garlic)

Table 4.7 Land allocations for multiple cropping patterns practiced by high diversified farm households in the study areas of southern Shan State, 2013

Cropping Patterns	Total No. of HH (N=60)	Townships								
		Hsihseng			Pindaya			Nyaung Shwe		
		No. of HH	Area (ha)	% of growing area	No. of HH	Area (ha)	% of growing area	No. of HH	Area (ha)	% of growing area
P - O - V	3 (5.0)	0	0	0	0	0	0	3	2.7	49.6
Pi –(M/ O)	28(46.7)	18	4.4	97.9	10	4.3	36.3	0	0	0
(M + O) - V	15 (2)	1	1.6	2.0	12	3.1	31.5	2	3.0	41.7
P - V - Others	5 (8.3)	0	0	0	5	2.6	11.1	0	0	0
V - V - V	9 (15.0)	0	0	0	8	2.8	18.7	1	1.4	8.7
HDG	60 (100)	19 (31.7)		100.	35 (58)		100	6 (6.7)		100

Note: P = Paddy, M = Maize, Pi = Pigeon pea, O = Oilseeds, Others = Ginger and Tea, V=Vegetables (Tomato, Mustard, Cabbage, Garlic)

The lower cropping intensity was attributed to the practice of mono crop of rice, sugarcane and maize for the entire cropping season. Because of cultivating more crops in cropping patterns, total effective acreage was 228.7 hectares in the high diversified group. Therefore, it could be explained that there was a higher chance of crop diversification with increasing cropping patterns. However, it could be low cropping intensity due to cultivating perennial crop such as sugarcane which had long growing period.

4.5 Credit Assess

In the crop production, credit is essential for farm households. Its maximum credit amount for paddy production was 100,000 Kyats per acre and was limited to ten acres per farmer. Myanmar Agricultural Development Bank (MADB) is administrating target- oriented credit program at subsidies interest rate with 0.45% per year for crop production in the study areas. Although MADB was paying credits to farmers for monsoon rice production, the amount of credit was insufficient to cover the requirements for crop production. Therefore, farm households had to take credit informally from other sources such as money lenders and relatives.

Percent of farm households received credit in the study areas of Southern Shan State (Figure 4.10). In LDG, 31.3% of low diversified farm households had taken credit from MADB and 20.2% of farm households received credit from money lenders. Moreover, 13.1% of low diversified farm households received agricultural credit from non-government organization like United Nation Development Programs (UNDP and other organization). In HDG, 29.7% of farm households received credit from MADB and 18.8% of farm households borrowed from money lenders for credit. Furthermore, 9.4% of high diversified farm households took credit access from non-government organization (NGO) like United Nation Development Programs (UNDP and other organization). However, 35.4% of low diversified farm households and 42.1% of high diversified farm households did not take any credit because farm households did not want to take financial risks in their crop production (Figure 4.10).

Low diversified farm households received credit amount of 50,000 MMK per hectare while 45,000 MMK per hectare was obtained by high diversified from MADB (Table 4.9). However, some diversified farm households borrowed money from private lenders, relatives. The credit amount was 154,000 MMK per hectare for

low diversified group and 192,000 MMK per hectare for high diversified group. NGO and other organization like UNDP lend credit amount of 98,000 MMK per hectare in low diversified group and 113,000 MMK per hectare in high diversified group.

Therefore, both diversified groups remain much more burdened credits by debt of informal and UNDP sources. Consequently, the credit agencies are more geared to the requirements of the small scale of farm activities to develop towards large scale of farm activities in future. However, it is not a very viable source of financing since it is usually inadequate credit support to their farm activities.

4.6 Constraints in Crop Production Challenged by Farm households in the Study Areas of Southern Shan State

According to the results, 76.7% of low diversified farm households and 23.3% of high diversified farm households were statistically significant in lack of access to technology in their crop production. Secondly, the result indicated that 53% and 47% of farm households in both groups, respectively, did not contact with extension officers to upgrade their crop production activities. Moreover, 53.3% of low diversified farm households and about 46.7% of high diversified group faced with low market price of crops (Table 4.10).

In addition, 63.3% of LDG and about 36.7% of HDG faced with crops failure by infestation of pests and diseases. Consequently, insufficient capitals could also be constraints like pest and disease problems. Farm households had insufficient capital to purchase the required materials for their crop protection. Crop products were sold by 53.3% of low diversified farm households and 46.7% of high diversified farm households to brokers who gave low prices immediately after harvesting. Therefore, some farm households had in debt for crop production. Furthermore, the study area was rainfed area which characterized by a low and uncertain rainfall. It ranges from 100 mm to about 280 mm, which was a challenge to farm households to sustain their crop production during the growing season.

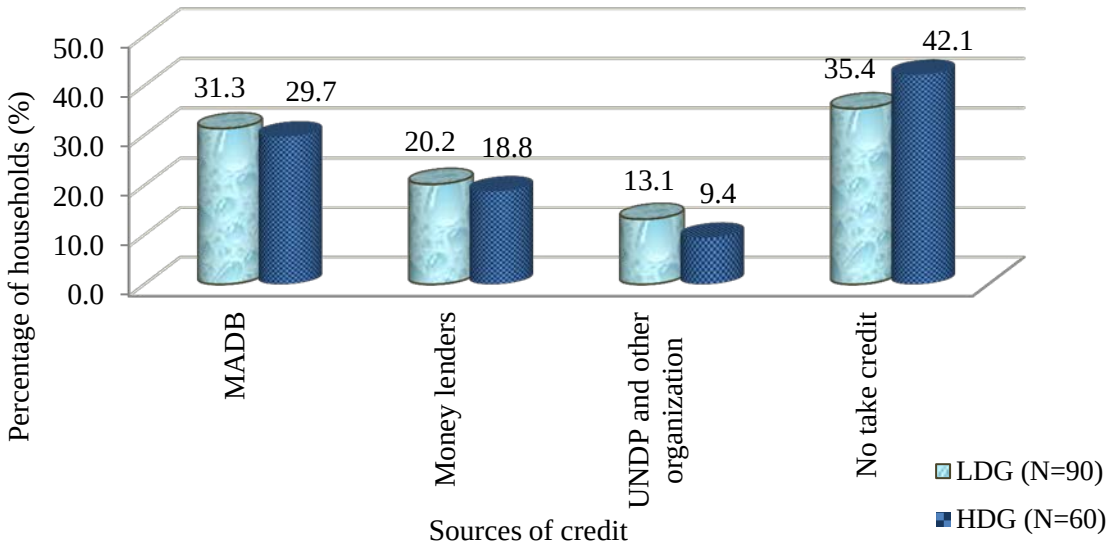

Figure 4.8 Percentage of farm households who received credit in the study areas of Southern Shan State, 2013

Table 4.8 Percentage of cropping intensity for farm households in the study areas of Southern Shan State

Item	LDG (n=90)		HDG (n=60)	Chi-square test
	Mono Cropping	Double Cropping	Multiple Cropping	
Average CI (%)	100.0	118.0	133.0	
Average of CI (%)	109.0		133.0	104.86***
Total Effective Area (ha)	56.5	196.0	228.7	
Range (%)	100 - 150		106 - 167	

Table 4.9 Credit received by farm households in the study area, 2013

Credit institutions	LDG (n = 90)	HDG (n= 60)	t-test
Average value of credit received in last year			
MADB ('000 MMK/ha)	50	45	1.59^{ns}
Money lenders ('000MMK)	154	192	0.97^{ns}
UNDP and other organization (‘000 MMK)	98	113	0.70^{ns}

Notes: ns indicates non-significant.

About 61.7% of low farm households and 38.3% of high diversified farm households faced with drought in their crop activities during the growing season (Table 4.10). Therefore, it is undoubtedly true that these constraints were responsible for the poor efficiency in using the resources and crop production in the study area.

4.7 Determinants of Crop Diversification Index in the Southern Shan State

The determinants of output included in the regression model for crop diversification index were number of crops, amount of credit received by farm households, schooling years, farming experiences, and farm size and dependency ratio.

The result of regression model is described in Table 4.11. The number of crops was negatively and significantly related to crop diversification index. It could be interpreted that the larger the number of crops in farming, the smaller crop diversification index would be in the study area. It was clearly indicated that low crop diversification index meant high diversification farming. Therefore, growing the various crops should be encouraged to boost up the crop diversification at micro level.

Then, the amount of credit was not significant but negatively correlated with crop diversification index. It showed that if it was smaller the amounts of credits received by farm households, crop diversification index value would be increased, that is, crop cultivation expressed low diversified farming as crop diversification index was large. It can be explained that farm households in the study area were poor in purchasing power due to low amounts of credits available which prohibited increasing crop diversification. It shows that the crop diversification was influenced by the average amount of credit obtained by individual household in the study area.

Farm household head's schooling year was important as one of the major roles in determining for crop diversified farming. Farm household heads who had many schooling year could make the best decisions in farm activities to lead the crop diversification for increasing crop income. The result indicated that household head's schooling year was negatively correlated with crop diversification index. If household head's schooling year increased by 1%, crop diversification would be decreased by 0.31. It indicated that crop cultivations were approached to high diversification if farm household heads had many schooling years.

The estimated coefficient of farming experience was positively related to crop diversification index although it was not significant. If one percent was increased in farm experience years, farm households might contribute to increase on crop diversification index. It could be interpreted that if farm activities were experienced for many years, crop diversification index would be larger. Therefore, farm households practiced low diversified farming (specialization) in the study area.

The regression coefficient of farm size was negatively and it was highly significantly correlated with crop diversification. It indicated that if farm size decreased by 1%, crop diversification index would increase by 0.102%. It showed that the smaller the farm size, the larger the crop diversified index would be and farm households practiced low diversified farming (specialized farming) in the study area.

The model revealed that it was highly significant at the 1% level and the value was 35.83 in F test. The adjusted R square pointed out that model could be explained the variation in crop diversification index by 58.4% for diversified farm households in the southern Shan State (Table 4.10).

Table 4.10 Constraints faced by farm households in their crop productions in the study areas of southern Shan State, 2013

Constraints	LDG (n = 90)	HDG (n = 60)	Chi-square test
Lack of access to technology	76.7	23.3	10.17**
Inadequate inputs	65.0	35.0	0.66 ns
Disease & Pest problem	63.3	36.7	0.46 ns
Face with drought	61.7	38.3	0.18 ns
Low market price of crops	53.3	46.7	2.43 ns
Non- contact with extension staff	53.0	47.0	0.11 ns

Notes: ns stands for significance.

Table 4. 11 Determinants of crop diversification in the Southern Shan State, 2013

	Unstandardized		Standardized	t- value	Sig.
	β	Std. Error	Beta		
(Constant)	1.00***	0.06		16.70	.00
Lnnumber of crops	- 0.14***	0.01	- 0.07	- 13.25	.00
Lnamount of credit	- 0.00^{ns}	0.00	- 0.08	- 1.44	.15
Lnschooling years	- 0.00^{ns}	0.01	- 0.08	- 0.31	.76
Lnfarming experiences years	0.03^{ns}	0.02	0.09	1.65	.10
Lnfarm size	- 0.05***	0.02	- 0.16	- 2.82	.00
Lndependency ratio	0.01^{ns}	0.03	0.02	0.37	.71

R^2 = 0.61

Adjust R^2 = 0.584

F value = 35.83

Dependent variables = Crop diversification index

Note: *** indicates statistical significance at 1% level and ns states non-significant.

CHAPTER V

RESULTS AND DISCUSSION

CROP DIVERSIFICATION IN CENTRAL MYANMAR

This chapter was focused on understanding the crop diversification of farm households in the study areas of Central Myanmar. In relation to increase income and improve farm households' living standards, this study represented return per unit area for various crops, return per unit of labour use in farm activities. Subsequently, to complete the objectives of study, the econometric analysis was performed through the multiple regression method to estimate the factors influencing the crop diversification.

5.1 Classification of Crop Diversification in the Study Areas of Central Myanmar

Farm households grew the various crops (Figure 5.1). Single crop was cultivated by 10% of farm households whereas 41.8% cultivated double crops which included in the low diversified group. Three crops per year were grown by 28.3% of farm households on their owned land as high diversified group. Moreover, four, five and six crops in one year were cultivated by 13.5%, 4.7% and 1.8% of farm households, respectively.

According to the objective of the study, farm households were categorized two level of diversification at farm level by using Herfindahl Index method (H_d) in the study area as follow;

$$H_d = \sum_{j=1}^{J} \left[\frac{Y_j}{\sum_{j=1}^{J} Y_j} \right]^2 \qquad 0 \leq H_d \leq 1 \qquad \text{(Ogundari 2013)}$$

Where, Y_i = Income share contributed by the j^{th} crop in farm income

Y = Farm income of the households

J = Total number of crops

H_d approaches zero with increasing diversification and equals to one when there is complete specialization in a single farming activity.

The result indicated that 52% of total farm households was in LDG and 48% of total farm households was in HDG. Average crop diversification index of low diversified farm households was 0.62 in the range of 0.5 to 1.0. For high diversified group, average index was 0.34 in the range of 0.0 to 0.5 (Table 5.1). It indicated that there was statistically significant difference at 1% level between diversified groups.

5.2 Socioeconomic characteristics

Descriptive statistics were used to investigate the differences in socioeconomic characteristics of farm households according to degree of crop diversification. Table 5.2 illustrates the socioeconomic characteristics of diversified farm household groups. In table, average family size of both diversified groups was 6 members per household. In LDG, average farm household heads' age was 47.9 years in the range of 22 to 74 years. In high diversified household, average farm households' age was 49.6 years in the range of 25 to 76 years. An average year in farming experience of headed households in LDG was 26.3 years, ranging from 4 to 49 years. For high diversified farm group, average farm experiences of headed households was 26.7 years, with the range of 2 to 60 years.

In LDG, average schooling years of household heads was 6.2 years in the range of 2 to 15 years, and it was 6.8 years in high diversified group, with the range of 3 to 15 years. Approximately two-third of low diversified farm household heads (64.4%) had only primary education level. In HDG, nearly 60% of the household heads had primary level. Nearly 23% of low diversified farm household heads and nearly 29% of high diversified farm household heads had middle education level. Approximately 13% of low diversified farm households and 15% of high diversified farm households had higher education level. Dependency ratio (calculated as the number of young people under 14 years and elderly people over 60 years of age who are depending on 100 people in the working age group) for low diversified group was 47.1% and it was 46.0% for high diversified group. It can be explained that 100 persons in the working age group supported every 46 young and/or aged person. According to the results of the study, most of farm households in both diversified groups were male-headed by and it was statistically and highly significant at 1% level between groups. In low diversified group, male-headed households were 83% and it was 78% in high diversified group. However, as some females work in the crop productions, the result expressed that 17% of LDG and 12% of high diversified farm group were female headed households in the study areas.

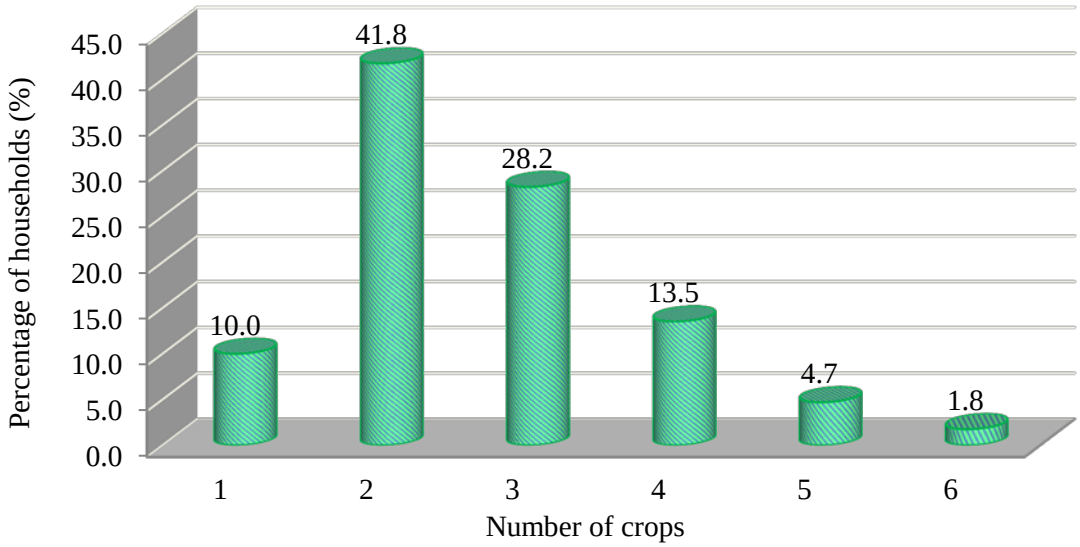

Figure 5.1 Percentage of farm households who cultivated the number of crops in Central Myanmar, 2016

Table 5.1 Crop diversification index of sample farm households in the study areas of Central Myanmar, 2016

Categories of Diversification	Index Range	No. of households	Average diversified index
Low Diversification group (LDG)	0.5 – 1.0	88 (52)	0.62
High Diversification group (HDG)	0.0 – 0.49	82 (48)	0.34
t-test		12.42***	

Note: Numbers in parenthesis are percent, *** indicates significant at 1% level.

Table 5.2 Socioeconomic characteristics of sample farm households in the study areas of Central Myanmar, 2016

Average items	LDG (n= 88)		HDG (n= 82)		t-test/ Chi-square test
	Average	Range	Average	Range	
Family size (No.)	5.7	3 - 12	6.2	2 - 14	-1.329^{ns}
Age of headed households (years)	47.9	22 - 74	49.6	25 - 76	-0.974^{ns}
Farming experience in years	26.3	4 - 49	26.7	2 - 60	-0.230^{ns}
Schooling years of headed households	6.2	2 - 15	6.8	3 - 15	-1.107^{ns}
Primary schooling years (%)	64.4		56.9		
Middle schooling years (%)	22.9		28.6		
Higher schooling years (%)	12.7		14.5		
Dependency ratio (%)	47.1		46.0		
Male headed households (%)	83.0		78.0		^{a}63.62***
Female headed households (%)	17.0		12.0		^{a}3.62***

Note: *** stated significant at 1 % level, ns indicates non-significant. a denoted Chi-square test.

5.3 Resource Availability Use

5.3.1 Farm size of sample households in the study areas

Average farm size of diversified sample households in the study areas of Central Myanmar was indicated in Table 5.3. Low diversified farm households owned 2.8 hectares in the range of 0.4 to 8.1 hectares. High diversified farm households owned 3.9 hectares in the range of 0.8 to 18.2 hectares. Farm size was statistically and highly significant at 1% level between groups. Percentage of cultivated land under 2 hectares was nearly 30% in low diversified farm households and 18.3% in high diversified farm households. Percentage of cultivated land between 2.01 hectares and 4 hectares was approximately 48% in low diversified farm household group and nearly 49% in high diversified farm households. Percentage of cultivated land above 4.01 hectares was nearly 23% in low diversified farm households and nearly 33% in high diversified farm households. The result indicated that percentage of farm households who cultivated small area (under 2.0 hectares) in low diversified group was higher than the percentage of farm households under 2.0 hectares in high diversified group. Therefore, high diversified group owned comparative large cultivated land areas than low diversified group.

5.3.2 Crop sown area in the study area

Number of crops sown by diversified sample farm households in the study areas of Central Myanmar was described in Table 5.4. Most of low diversified farm households in all townships; Yamethin Township (40.7%), Tatkone Township (27.1%) and Magway Township (57.7%) practiced double cropping system. In high diversified farm group, most of farm households in Yamethin (32.2%), Tatkone (39.0%) and Magway (11.5%) cultivated three crops. Some farm households in Yamethin (10.2%), Tatkone (8.5%) and Magway (25.0%) practiced four crops. Some in Yamethin (1.7%) cultivated both five and six crops. In Tatkone Township, 10.2% of high diversified farm households cultivated five crops and 3.4% of high diversified farm households practiced six crops.

Average sown area of diversified farm households in the study area was indicated (Table 5.5). In LDG, average sown area of sesame was 4.92 hectares in the range of 0.4 hectares and 11.94 hectares. It was statistically and highly significant at 5% level between diversified groups. Average sown area of groundnut was 3.42 hectares in the range of 0.4 hectares and 12.34 hectares. Average sown area of green

gram was 2.03 hectares in the range of 0.4 hectares and 6.07 hectares. Average sown area of paddy was 1.87 hectares in the range of 0.61 hectares and 4.05 hectares. Average sown area of maize was 1.09 hectares in the range of 0.4 hectares and 2.81 hectares. Average sown area of pigeon pea was 1.85 hectares in the range of 0.81 hectares and 3.16 hectares. Moreover, average sown area of cotton was 1.31 hectares in the range of 0.61 hectares and 2.02 hectares. Average sown area of cowpea was 0.91 hectares in the range of 0.61 hectares and 1.21 hectares. In addition, average sown area of cabbage was 0.88 hectares in the range of 0.4 hectares and 1.21hectares.

In high diversified group, average sown area of sesame was 3.21 hectares in the range of 0.4 hectares and 12.14 hectares and 2.89 hectares in the range of 0.4 hectares and 18.2 hectares for groundnut. Green gram was cultivated on average of 2.15 hectares in the range of 0.3 hectares and 12.14 hectares. Paddy was sown on average of 1.97 hectares in the range of 0.4 hectares and 5.67 hectares and 0.78 hectares on average for maize in the range of 0.4 hectares and 4.05 hectares. Furthermore, pigeon pea was cultivated 1.39 hectares on an average in the range of 0.4 hectares and 6.07 hectares while cow pea was sown on an average of 1.53 hectares in the range of 0.4 hectares and 3.24 hectares. Black gram was cultivated 0.75 hectares on an average in the range of 0.4 hectares and 2.02 hectares while chick pea was sown on an average of 0.94 hectares in the range of 0.4 hectares and 1.21 hectares. In addition, sunflower was cultivated 1.59 hectares on an average in the range of 0.8 hectares and 4.05 hectares while cabbage was sown on an average of 0.48 hectares in the range of 0.2 hectares and 1.21 hectares. Average sown area of chilli was 0.5 hectares in the range of 0.2 hectares and 1.21 hectares in the study areas of Central Myanmar (Table 5.5).

Therefore, the result described that sesame, groundnut and green gram were the largest cultivated areas in the study areas of Central Myanmar. The common and large sown areas of crops in both diversified groups were sesame, groundnut, green gram, paddy and pigeon pea. Both groups had also grown cow pea, cow pea, cotton, cabbage and chilli. Average sown area of these crops were not significant different in two groups. Only high diversified group grew black gram and sunflower.

Table 5.3 Average farm size of sample households by level of diversification farm in Central Myanmar, 2016

Items	LDG (n= 88)			HDG (n= 82)			t-test/ Chi-square test
	Average	Max.	Min.	Average	Max.	Min.	
Farm size	2.8	8.1	0.4	3.9	18.2	0.8	- 3.12***
Cultivated land area							
< 2.0 ha	29.5			18.3			[a] 53.13**
2.01 ha 4.0 ha	47.7			48.8			
> 4.01 ha	22.7			32.9			

Note: ** and *** indicates significant at 5% and 1% level. a denotes Pearson chi-square test.

Table 5.4 Number of crops sown by sample farm households in the study areas of Central Myanmar, 2016

Townships	LDG (n= 88)			HDG (n= 82)					Total (n=170)
	Mono	Double	Total No.HH	3 crops	4 crops	5 crops	6 crops	Total No.HH	
Yamethin	8 (13.6)	24 (40.7)	32 (54.2)	19 (32.2)	6 (10.2)	1 (1.7)	1 (1.7)	27 (45.8)	59 (100)
Tatkone	7 (11.9)	16 (27.1)	23 (39.0)	23 (39.0)	5 (8.5)	6 (10.2)	2 (3.4)	36 (61.0)	59 (100)
Magway	3 (5.8)	30 (57.7)	33 (63.5)	6 (11.5)	13 (25.0)	0 (0)	0 (0)	19 (36.5)	52 (100)
Total	18 (10.5)	70 (41.2)	88 (51.8)	48 (28.2)	24 (14.1)	7 (4.1)	3 (1.8)	82 (48.2)	170 (100)

Note: Numbers in parenthesis are percent. HH= Household heads

Table 5.5 Average crops sown area by diversified sample farm households in the study area, 2016

Crops	LDG (n= 88)			HDG (n= 82)			t-test
	Average area (ha)	Max.	Min.	Average area (ha)	Max.	Min.	
Sesame	4.92	11.94	0.40	3.21	12.14	0.4	1.70**
Groundnut	3.42	12.34	0.40	2.89	18.20	0.40	0.53^{ns}
Green gram	2.03	6.07	0.40	2.15	12.14	0.30	-0.33^{ns}
Paddy	1.87	4.05	0.61	1.97	5.67	0.40	-0.24^{ns}
Maize	1.09	2.81	0.40	0.78	4.05	0.40	0.82^{ns}
Pigeon pea	1.85	3.16	0.81	1.39	6.07	0.40	0.78^{ns}
Black gram	-	-	-	0.75	2.02	0.40	
Chick pea	0.51	0.61	0.40	0.94	1.21	0.40	- 1.22^{ns}
Cowpea	0.91	1.21	0.61	1.53	3.24	0.40	- 1.12^{ns}
Sunflower	-	-	-	1.59	4.05	0.8	
Cotton	1.31	2.02	0.61	0.79	1.21	0.40	1.25^{ns}
Cabbage	0.88	1.21	0.40	0.48	1.21	0.20	1.40^{ns}
Chilli	0.61	0.61	0.61	0.50	1.21	0.20	0.29^{ns}

Note: ** stands for significant at 5% level and ns did not stand for significant.

5.4 Crop Production

5.4.1 Cropping patterns in Central Myanmar

The cropping patterns cultivated by diversified farm households in the study area were indicated in Figure 5.2. In low diversified group, 13.6% of farm households in Yamethin Township, 11.9% in Tatkone Township and 5.8% in Magway Township cultivated mono cropping. Next, 40.7% of low farm households in Yamethin Township, 27.1% in Tatkone Township and 57.7% in Magway Township cultivated double cropping. In high diversified group, 45.8% of farm households in Yamethin cultivated triple cropping successively. Next, 61.0% in Tatkone Township and 36.5% in Magway Township cultivated multiple cropping more than three crops.

As mentioned above, higher number of farm households in Yamethin Township practiced mono cropping more than Tatkone and Magway Townships. Farm households (57.7%) in Magway Townships were larger than other two townships practiced in double cropping. However, in high diversified group, 61.0% of farm households in Tatkone Township practiced multiple cropping than other townships.

5.4.2 Cropping patterns practiced in low diversified farm households in the study area

In the study area, the result indicated that there were four cropping patterns; (1) legume based cropping patterns, (2) maize based cropping patterns, (3) rice based cropping patterns and (4) oilseeds-based cropping patterns in the low diversified group.

Legume-based double cropping patterns were practiced by 22.7% of low diversified farm households in Yamethin Township and 11.4% in Tatkone Townships. Maize-based double cropping patterns were practiced by 6.8% of farm households in Tatkone Township. About 3.4% of farm households in Yamethin Township practiced rice-based cropping pattern. About 35.2% of farm households in Magway Township cultivated oilseed-based double cropping patterns (Table 5.6).

Therefore, the overall results of this study area indicated that 34.1% of low diversified farm households cultivated legume based cropping patterns. Maize based double cropping patterns were adopted by 6.8% of low diversified farm households while rice-based cropping patterns were done by 3.4% of low diversified farm

households. Finally, 35.2% of low diversified farm household heads cultivated oilseeds-based cropping patterns (Table 5.6).

According to the results shown in Figure 5.2, farm households grew paddy and green gram as mono crops in Yamethin Township. Farm households cultivated paddy from June to first week of November and green gram was cultivated from June to August, after the land was fallowed.

In Tatkone Township, paddy was cultivated staring from the end of June through November and maize was cultivated from the end of April to the first week of October as mono cropping. Some farm households grew green gram from the mid-June to the end of August and chilli was grown from mid-May to October and then the land was fallowed. In addition, some farm households cultivated cabbage from the mid-October to the end of December as winter crop. In Magway Township, few farm households cultivated sesame. Oilseeds (sesame) was cultivated from the mid-May to mid- August and then the land was fallowed (Figure 5.3).

Legume-based cropping patterns and maize-based cropping patterns were practiced as double cropping in the study area. In Yamethin Township, after sowing green gram from May to July, paddy was sown from August to November. Some farm households sowed green gram from May to July in early monsoon and then cotton was cultivated from mid-August to December. However, some sowed chilli from August to December after green gram and some cultivated green gram from May to July followed by the cotton from August to December. In rice-based cropping, some farm households grew paddy from May to mid-August and pigeon pea from August to March. Some cultivated cotton from August to December following the paddy.

In Tatkone Township, maize was cultivated from May to mid-October and cabbage (November-January) was followed by maize. Paddy (end of August-to December) was followed by green gram (May-July). Chick pea was cultivated from November-January and black gram (October-December) was followed by maize crop sown from May to September.

In Magway Township, farm households cultivated cowpea and sesame followed by the groundnut from May to September. Cow pea was sown from the mid of October to December and sesame was cultivated from mid-October to February during the growing period (Figure 5.4).

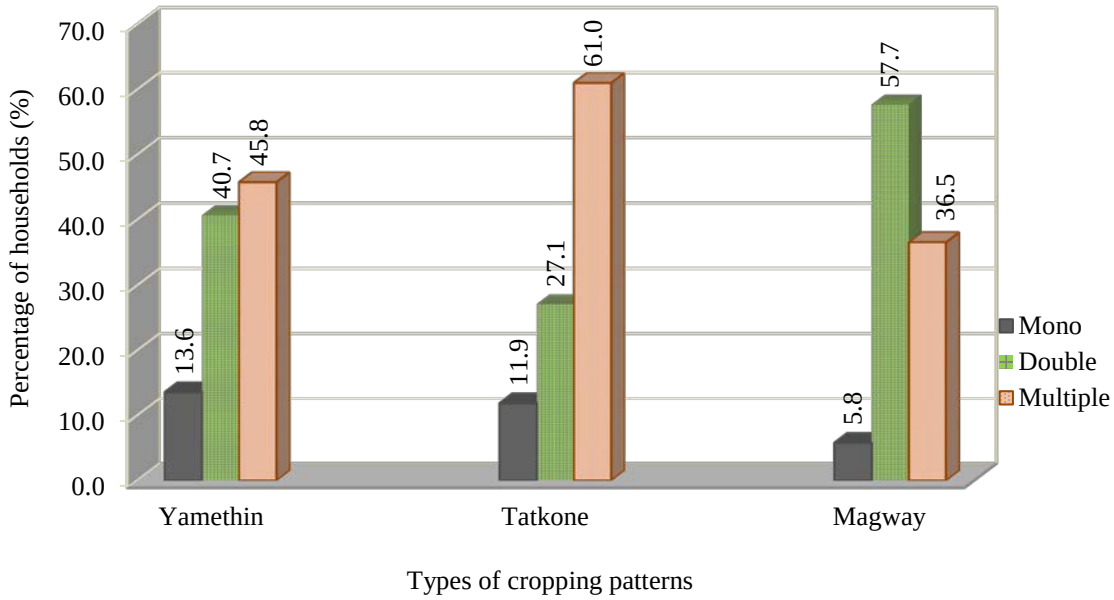

Figure 5.2 Cropping patterns practiced by diversified households in the Central Myanmar

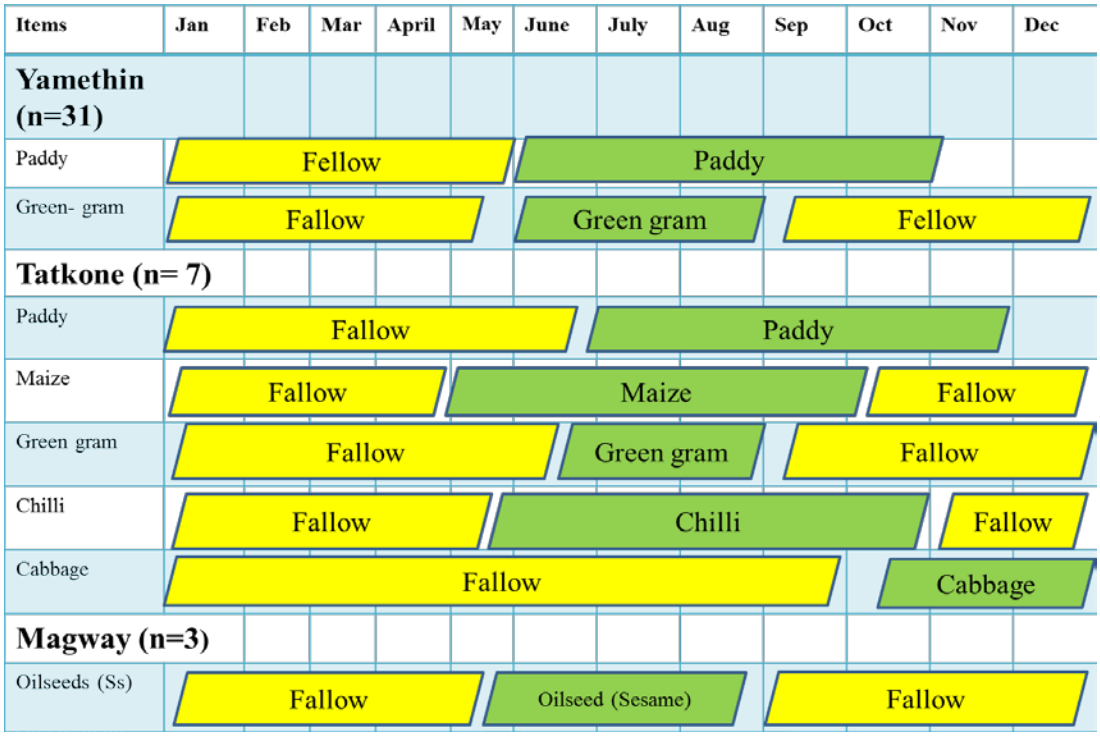

Figure 5.3 Major crops in mono cropping practiced by low diversified group in the study areas of Central Myanmar, 2016

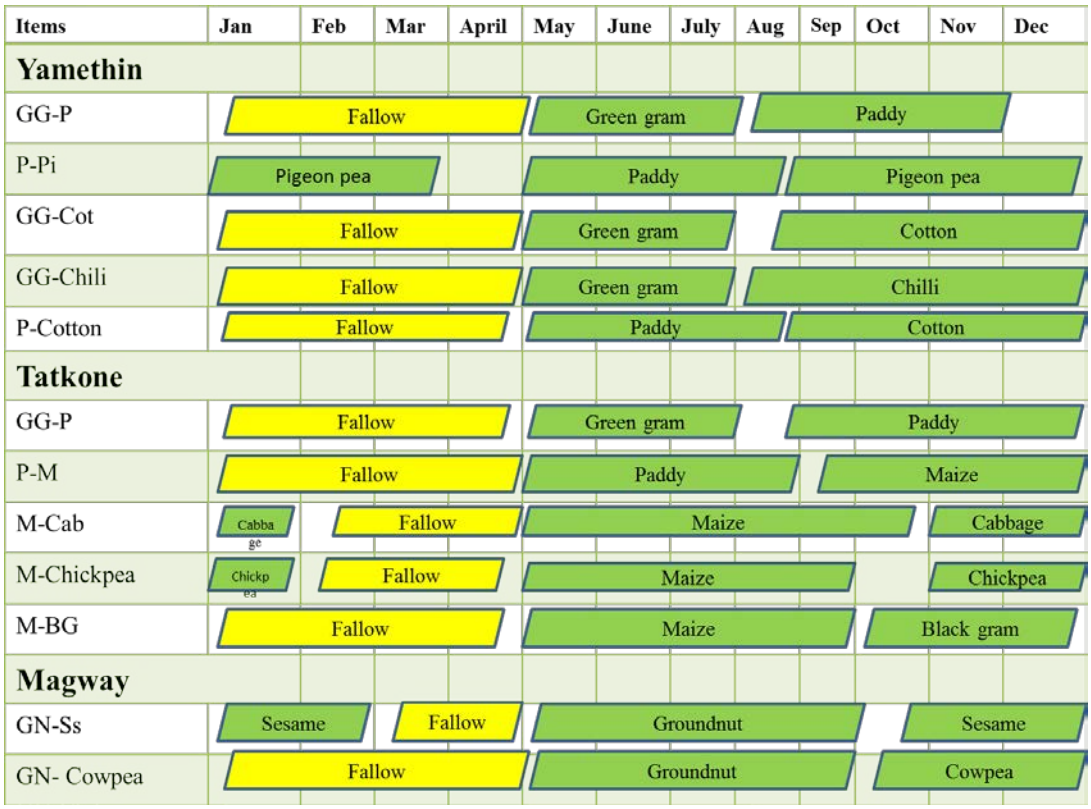

Figure 5.4 Double cropping pattern practiced by low diversified group in the study areas of Central Myanmar, 2016

Table 5.6 Percentages of cropping patterns commonly practiced by farm households in Central Myanmar, 2016

Types of Group	Cropping Patterns	% of households			
		Yamethin	Tatkone	Magway	Total
Low Diversified Group	**Mono cropping**	-	-	-	**20.5**
	Double cropping	-	-	-	**79.5**
	- Legume-based cropping	22.7	11.4	-	34.1
	- Maize-based cropping	-	6.8	-	6.8
	- Rice-based cropping	3.4	-	-	3.4
	- Oilseeds-based cropping	-	-	35.2	35.2
High Diversified Group	**Multiple cropping patterns**	-	-	-	**100**
	-Legume-based cropping Patterns	34.1	30.5	17.1	81.7
	-Maize-based cropping Patterns	-	8.4	4.9	13.4
	- Rice- based cropping Patterns	-	4.9	-	4.9

5.4.3 Cropping patterns practiced in high diversified households in the study area

In the study area, the result indicated that there were three cropping patterns; (1) legume based cropping patterns, (2) maize based cropping patterns and (3) rice based cropping patterns in the high diversified group.

In high diversified group, legume-based multiple cropping patterns were practiced by 34.1% in Yamethin Township, 30.5% in Tatkone Township and 17.1% in Magway Township. Maize-based multiple cropping patterns were practiced by 8.5% in Tatkone and 4.9% in Magway Townships, while 4.9% of high diversified farm households practiced only rice-based cropping pattern in Tatkone Township. Therefore, the result indicated that 81.7% of farm households cultivated legume-based cropping patterns in high diversified group. Maize-based multiple cropping patterns (13.4%) and rice-based multiple cropping patterns (4.9%) were found in the high diversified group (Table 5.6).

For high diversified households in Yamethin Township, farm household heads cultivated paddy followed by green gram and continued to grow chilli. Green gram was sown from mid-May to July and paddy was sown from August to November and continued to grow chilli from December to March. Some farm households cultivated green gram mixed cotton and followed by paddy. They cultivated paddy from the end of April to August and continued to grow green gram from September to October. After sowing green gram, cotton was sown from the end of October to February on that plot.

Farm household heads cultivated green gram-paddy-sunflower cropping pattern during the growing period. Green gram was cultivated in the end of May and harvested in mid-August. Paddy was continued to cultivate in the August and harvested in the end of November. Some continued to cultivate sunflower in the end of November to March during the growing season (Figure 5.5).

In addition, farm households in the high diversified group cultivated paddy followed by green gram in the monsoon season and continued to grow groundnut or vegetables as winter crop in Tatkone area. Green gram was grown in May and harvested in mid-July. Paddy was grown in mid-July and harvested in mid-October. Groundnut was grown from mid-October to December and grown Vegetables (cabbage) was sown from November to December during growing season in year. Some farm households cultivated green gram- paddy-sunflower cropping pattern. Green gram was sown from mid-May to July and continued to grow paddy from August to November and then sunflower was cultivated from December to first week

of March. Moreover, some farm households in Tatkone Township cultivated bringal followed by maize and continued to grow chick pea. Therefore, maize was grown in May and harvested in September. Brinjal was cultivated in October and harvested in December. After that, chick pea was cultivated in January after cleaning the brinjal plants and it was harvested in March Some cultivated sunflower (October-December) followed by maize and cowpea as mix cropping (Figure 5.6).

In Magway Township, some high diversified households cultivated groundnut followed by green gram and continued to grow sesame. Maize with cowpea as mixed crops followed by sesame and pigeon pea with green gram as mixed crops and then groundnut continued to grow after harvesting green gram as multiple cropping. Maize was grown from mid-July to November and cowpea was mixed with maize from October to mid-December. And then, sesame was continued to grow from January to April. Green gram was grown in June to second week of August and groundnut was grown in the end of August and harvested in December (Figure 5.6).

5.4.4 Cropping intensity

The percentage of cropping intensity for farm households was indicated in Table 5.7. The cropping intensities of low and high diversified farm households groups were 134% and 179%. The percentage of cropping intensity was 100% intensity in mono cropping of LDG and 168% intensity in double cropping of high diversified farm group in the entire cropping season. In addition, cultivating multiple cropping patterns made great total effective acreage (576.3 hectares) in the high diversified group and it was statistically and highly significant between diversified farm groups. Therefore, it could be shown that increasing cropping patterns was a higher chance of crop diversification.

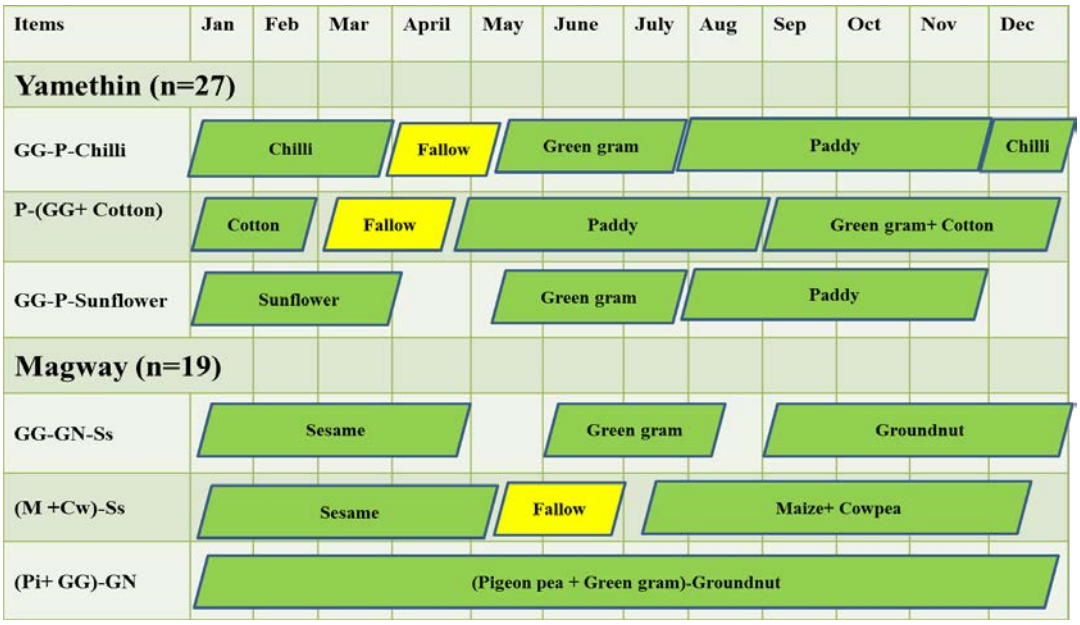

Figure 5.5 Multiple Cropping patterns practiced by high diversified group in Ya1methin and Magway Townships of Central Myanmar, 2016

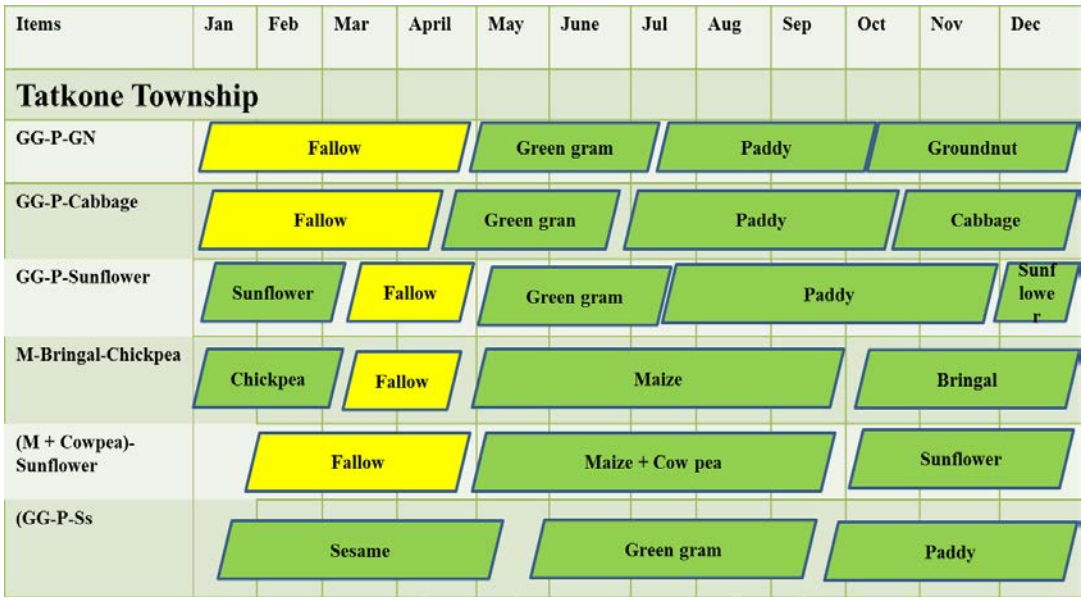

Figure 5.6 Common crops in multiple Cropping patterns of high diversified group in Tatkone Township, Central Myanmar, 2016

Table 5.7 Cropping intensities of farm households in the Central Myanmar, 2016

Items	LDG (n= 88)		HDG (n= 82)	Chi-square test
	Mono Cropping	Double cropping	Multiple cropping	
CI (%)	100	168	179	97.27***
Average CI (%)	134		179	
Total Effective Area	31.57	308.43	576.30	

Notes: *** stand for significant at 1% level in Pearson chi-square test.

5.5 Credit Access

Credit is necessary for farm households for increasing crop production. The government provided credit to make more investment for farm households in crop production. Amount of credit has been increased for rice from 20,000 MMK per acre to 100,000 MMK per acre in 2013-14 (MOAI 2014). However, credit amount for paddy production was limited up to ten acres at most per farmer.

In the study areas, there are three sources of credit; namely, Myanmar Agricultural Development Bank (MADB), Microfinance institution at village level, pawn shop and money lenders which are providing in cash and in kind. Among these credit sources, MADB was the formal credit source. In addition, most of farmers borrowed money from private lenders, informal credit sources such as pawn shop, shopkeepers in the villages, brokers and crop traders. Farmers usually borrow cash to purchase inputs for crop production such as seed, chemical fertilizer and pesticides in their villages. The interest rate from private lender is much higher than that from MADB. Informal credit sector had to pay money back after harvesting with different interest rate from 3 to 5 percent per month with collaterals like gold jewelries. Formal sector (MADB) was paying credits to farmers for monsoon rice production and industrial crops such as cotton and sugarcane. However, the amount of credit was inadequate for the requirements in the crop productions.

In LDGs, 46.3% of farm households had taken credit from MADB and 23.1% of farm households received from institutions such as other organizations or local society community at village. In addition, 16.4% of low diversified farm households received money from private lenders (informal credit sector). However, 14.2% of low diversified farm households desired to avoid the risk in finance and then they did not borrow any money. In the high diversified group, 41.5%, 25.5% and 23.6% of high farm households received credit from MADB, microfinance institutions and private lenders, respectively. However, 10.6% of high diversified farm households did not take any credit because farm households did not need capital in their crop productions (Figure 5.7).

Credit amount received by diversified farm households in the study area in Table 5.8. In the low diversified group, farm household heads took credit from MADB with amount of 238,000 MMK per hectare. In corporative credit from organization at village, low diversified farm households borrowed 114, 000 MMK per hectare and repaid them after crop growing season. In addition, some low

diversified farmers borrowed money (248, 000 MMK per hectare) from private lenders.

In high diversified group, 245, 000 MMK per hectare was received from MADB (formal) credit sector and repaid after crop growing season. In money lenders (informal) credit sector, some farm households received money (698, 000 MMK per hectare). Furthermore, some farmers had taken 109,000 MMK per household from corporation at village and they repaid at the end of year. Therefore, the rural credit is imperative role to both diversified farm households in the study area.

5.6 Farm Households' Views on Constraints in their Crop Productions

Farmers were asked about constraints and problems of their crop productions. There were seven questions concerning with the constraints such as labour scarcity, low market price of crops, high cost for seed, insufficient capital, less access to technology, pest and disease infestations and flood (Table 5.9).

According to the results of their constraints, 69.3% of low diversified farm households faced with labour scarcity during growing season. About 76.1% of low diversified farm households expressed that they gave the high price for seed varieties. However, 67% of low diversified farm households received low market price of crops when they sell their farm products. Therefore, 67% of low diversified farm households required capital investments in their crop productions. About 73.9% of low diversified farm households answered that they did not have exposure to extension staffs for advices on growing crops. The pest and disease and flood were faced by 60.2% and 34.1% of low diversified farm household respectively.

The results showed that one-third of farm households faced with flood due to being heavy raining in the crop year 2015-16. Therefore, 29.3% of high diversified farm households faced with decreasing crop yield. In addition, low market price for crop products was received by 74.4% of high diversified farm households. Decreasing market prices of relative crops and declining crop yields might decrease the economic return to scale. Therefore, some farm households were in debt for crop production.

In addition, although labour is essential to crop production, labour in farming was scared in the study areas. It indicated that 79.3% of high diversified farm households faced with difficulties to hire labour in their crop productions. About 54.9% of high diversified farm households had lack of technologies about crop

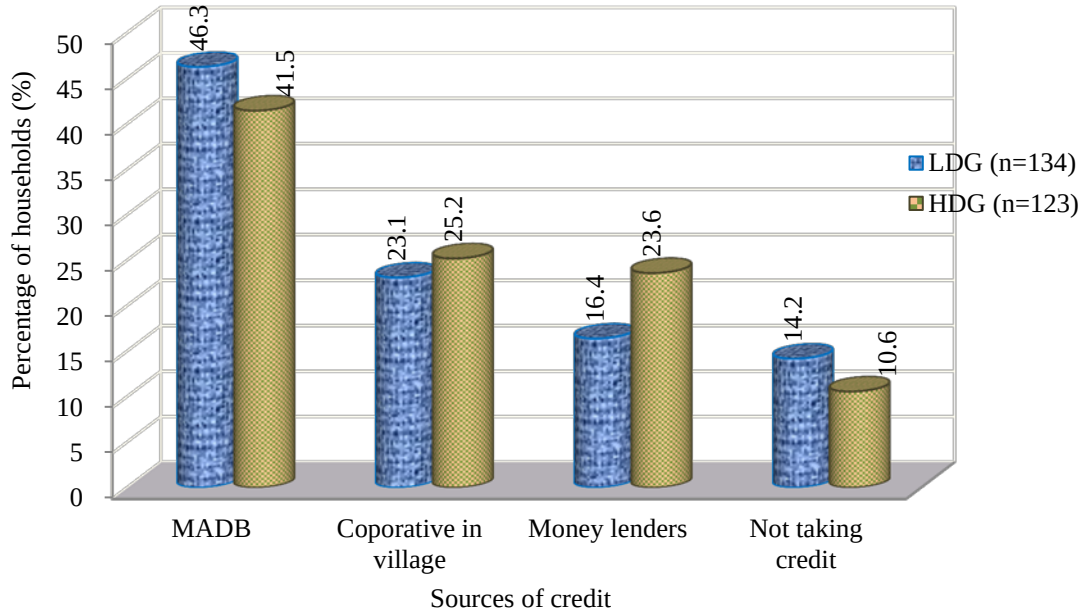

Figure 5.7 Credit accesses of diversified households in the Central Myanmar, 2016

Table 5.8 Average value of credit received by diversified farm households in the study areas of Central Myanmar, 2016

Items	Credit ('000 MMK/ha)		t-test
	LDG (n=88)	HDG (n=82)	
MADB	238	245	1.66**
Money lenders	248	698	-2.08**
Corporative at village	114	109	0.32^{ns}

Note: ** indicates significant at 5% level and ns denotes non-significant.

Table 5.9 Constraints of diversified sample households in the Central Myanmar,

Items	LDG (n= 88)		HDG (n= 82)		Chi-square test
	No. HH	%	No. HH	%	
Labour scarcity	61	69.3	65	79.3	18.45***
Low market price of crops	59	67.0	61	74.4	25.62***
High seed cost	67	76.1	51	62.2	8.49***
Insufficient capital	59	67.0	47	57.3	13.55***
Less access to technology	65	73.9	45	54.9	10.38***
Pest Infestation	53	60.2	41	50.0	1.91^{ns}
Flood	30	34.1	24	29.3	22.61***

Note: ** and *** indicates significant at 5% and 1 % level. ns indicates non- significant.
HH= Household heads

production. These information would help to explain why crop diversification did not increase over the year.

Furthermore, 57.3% of high diversified farm households expressed that credit access was insufficient. Insufficient capital for diversified farm households was also a problem to purchase the required materials for their crop production. In addition, 50% of high diversified farm household faced with crops failure by pest and disease infestation. The result showed that one-third of farm households faced with flood due to being heavy raining in the crop year 2014-15. Therefore, 29.3% of high diversified farm households faced with decreasing crop yield. In addition, low market price for crop products was received by 74.4% of high diversified farm households. Decreasing market prices of relative crops and declining crop yields might decrease the economic return to scale. Therefore, some farm households were in debt for crop production.

5.7 Households Income for Diversified Farm Households in the Study Area

Most of the farm households desired to increase their family income by selling agricultural products in nearby markets. Consequently, they are able to buy food and other household requirements from the same market due to the higher economic return. Therefore, increasing household income is important social determinant for increasing diversified systems. Farm households' income was defined as income from agricultural activities, business, commercial and industrial establishment, land property, rent, gift and assistance, insurance benefits which included other special types of receipts by household members estimated on yearly basis (UN 1984).

In the study, farm household income was defined that all the household members earned in exchange for good and services as material return in cash or in kind and were related to the reference during the survey period. They generated income through farming activities including crop production and livestock production. Crop income include production value of paddy, green gram, maize, pigeon pea, groundnut, sesame, sunflower, black gram, chick pea, cow pea, cotton, chilli and vegetables such as cabbage, brinjal and tomato in rainfed area. Additional income came from agricultural off-farm activities and non-farm activities included government salaries, company salaries, and other works.

Furthermore, livestock production can distribute additional extra income to

sustain their livestock as a form of savings. Therefore, this component is very important in the farming system. Although the livestock income is an alternative source of the farmer's capacity for further investment, the results of the study revealed that farm households raised mostly cattle and buffaloes to work as draft power in their farm activities. Some farm households raised pigs and chickens not only consumed for home but also for sale and it could contribute to additional income to sustain their livestock as a form of savings. In the low diversified group, the results indicated that crop production contributed 31% to households' income while 5% of total incomes came from livestock production. Agricultural on-farm activities contributed 14% to household incomes while 50% of household income was from non-farm activities (Figure 5.8). In the high diversified group, crop production contributes to 47% to farm households' incomes while 3% of total income came from livestock production. Agricultural on-farm activities contributed 15% to that while 35% of that of income was from non-farm activities (Figure 5.9).

Therefore, the results indicated that crop income was the main source and non-farm income was the second source of farm households in high diversified groups. Livestock production was one of income sources as an extra earning for diversified farm households group. Since livestock production was rare in the study areas of Central Myanmar, there were neither any technological supports nor livestock or cooperative offices that provide services to guide the farmers for successful livestock production in the study area.

5.8 Gross Margin Analysis of Crops by Diversified Farm Households heads in the Study Areas of Central Myanmar

The results described the profitable crops which cultivated in the study areas of Central Myanmar. Farm households cultivated paddy, green gram, sesame, groundnut, maize, black gram, pigeon pea, chick pea, sunflower. In addition, cotton was cultivated as industrial crop. Moreover, cabbage and chilli were cultivated as cash crop for their livelihoods.

5.8.1 Gross margin analysis for low diversified households

Gross margin analysis of mono cropping was practiced by low diversified sample farm households in the Central Myanmar (Table 5.10). In Yamethin Township, Benefit Cost Ratio (BCR) of green gram was 1.64 which gave the highest

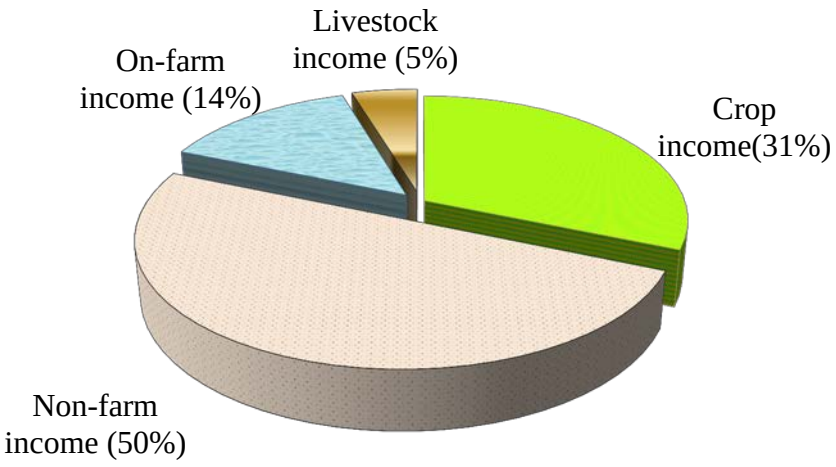

Figure 5.8 Income compositions of low diversified sample farm households in the study areas of Central Myanmar, 2016

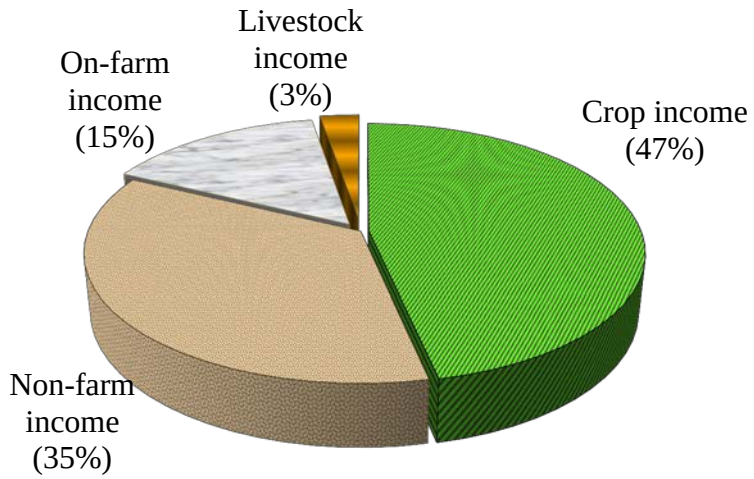

Figure 5.9 Income compositions of high diversified sample farm households in the study areas of Central Myanmar, 2016

profit in low diversified farm households. Gross Benefit (value of farm products) of low diversified farm households was 1,084,000 MMK per hectare. The gross margin per unit of land (net benefit) was 424,000 MMK per hectare and 660,000 MMK per hectare was total variable costs of production. Benefit cost ratio of paddy was low (1.04) for low diversified farm households group and gross benefit was 862,000 MMK per hectare. Therefore, gross margin per unit of land was 32,000 MMK per hectare and cost of production was 830,000 MMK per hectare.

In Tatkone Township, gross benefit of green gram for low diversified farm households was 1,215, 000 MMK per hectare as mono cropping. The gross margin per unit of land (Net benefit) for low diversified farm households was 465,000 MMK per hectare and BCR of green gram cultivation was 1.62. Cost of green gram production was 750,000 MMK per hectare and the return above variable cash cost was obtained 550,000MMK per hectare in green gram cultivation.

Benefit cost ratio of paddy was 1.20 and gross benefit was 1,498, 000 MMK per hectare for low diversified farm households group. Therefore, gross margin per unit of land (net benefit) was 253,000 MMK per hectare and total cost of production was 1,245,000 MMK per hectare in paddy cultivation as mono cropping. In Tatkone Township, gross benefit of cabbage cultivation for low diversified farm households group was 4,163, 000 MMK per hectare as mono cropping. The net benefit of low diversified farm households 2,109,000 MMK per hectare and BCR of cabbage cultivation was 1.94 and cost of cabbage production was 2,144,000 MMK per hectare. Benefit cost ratio of chilli cultivation was 1.88 and gross benefit was 3,285, 000 MMK per hectare for low diversified farm households group. Therefore, gross margin per unit of land was 1,535, 000 MMK per hectare and cost of chilli production was 1,750,000 MMK per hectare as mono cropping. In addition, gross benefit of maize cultivation of low diversified farm households group was 1,205,000 MMK per hectare as mono cropping. The gross margin per unit of land (net benefit) of low diversified farm households group was 231,000 MMK per hectare and BCR of maize cultivation was 1.24. Cost of maize production was 974,000 MMK per hectare in Tatkone Township. In Magway Township, gross benefit of low diversified farm households was 1,656,000 MMK per hectare in sesame cultivation as mono cropping. Variable cost of production of the low diversified farm households group was 908,000 MMK per hectare and the benefit cost ratio (BCR) was 1.82. Moreover, gross margin per unit of land in sesame production was 748,000 MMK per hectare in

Magway Township.

The results of gross margin analysis of double cropping in low diversified farm households group indicated in Table 5.11. In Yamethin Township, BCR of green gram-chilli cropping pattern was 1.98 in LDG. Gross benefit of green gram-chilli cropping pattern for low diversified farm households group was 4,891,000 MMK per hectare and cost of production was 2,468,000 MMK per hectare.

Therefore, gross margin per unit of land (net benefit) was 2,422,000 MMK per hectare in green gram-chilli cropping pattern. In low diversified farm households group, BCR of green gram-cotton cropping pattern was 1.56 and gross benefit was 2,569,000 MMK per hectare. Cost of production and net benefit in green gram-cotton were 1,642,000 MMK per hectare and 926,000 MMK per hectare, respectively. Moreover, BCR of green gram-paddy cropping pattern was 1.31 and 1.30 in paddy-cotton cropping pattern for low diversified farm households group. Gross benefits were 1,946,000 MMK per hectare and 2,347,000 MMK per hectare, in green gram-paddy and paddy-cotton cropping pattern, respectively. Costs of crop production were 1,489,000 MMK per hectare and 1,812,000 MMK per hectare, respectively, in green gram- paddy and paddy- cotton cropping pattern. Thus, net benefits for those of cropping patterns were obtained 456,000 MMK per hectare and 534,000 MMK per hectare. Furthermore, BCR of paddy-pigeon pea cropping pattern was 1.16 and 240,000 MMK per hectare in gross margin per unit of land, 1,771,000 MMK per hectare in gross benefit and 1,537,000 MMK per hectare in cost of production were found for low diversified farm households group in Yamethin Township.

In Tatkone Township, BCR of maize-cabbage cropping pattern was 1.72 and it was the most profitable cropping pattern in Tatkone Township. Gross benefit for this pattern was 5,369,000 MMK per hectare, 3,118,000 MMK per hectare and 2,225,000 MMK per hectare were used in cost production and in return above variable cash cost. Paddy followed by green gram cropping pattern obtained gross benefit (2,713,000 MMK per hectare) and 1,994,000 MMK per hectare was cost of production. Consequently, net benefit obtained amount of 719,000 MMK per hectare and benefit cost ratio was 1.36 in green gram-paddy cropping. Moreover, BCRs of maize-black gram and paddy-maize cropping pattern were 1.27 and 1.22, respectively. Gross benefits in those of cropping patterns were 2,230,000 MMK per hectare and 2,703,000 MMK per hectare, respectively. Cost of productions were 1,757, 000 MMK per hectare in maize-black gram cropping pattern and 2,219,000

MMK per hectare in maize followed paddy cropping pattern in Tatkone Township. However, BCR of maize-chick pea cropping pattern was 1.19 and gross benefit was amount of 2,165,000 MMK per hectare. Cost of production for maize-chick pea cropping pattern was 1,820,000 MMK per hectare and then return available variable cost (net benefit) was 344, 000 MMK per hectare in Tatkone Township. In Magway Township, low diversified farm households group who practiced sesame followed by groundnut cropping pattern obtained the net benefit (3,241,000 MMK per hectare) with 1.55 in BCR. The cost of production was 2,089,000 MMK per hectare and then gross margin per unit of land was 1,152,000 MMK per hectare in groundnut-sesame cropping pattern. The net benefit of cow pea followed by groundnut cropping pattern obtained the second smallest net benefit in gross benefit (2,245,000 MMK per hectare) with 1.34 of BCR in Magway Township. Furthermore, BCR of green gram-pigeon pea cropping pattern was 1.21 and gross benefit was 1,769,000 MMK per hectare. Then, gross margin per unit of land was 305,000 MMK per hectare in green gram-pigeon pea cropping pattern.

By summing up, green gram cultivation in Yamethin Township, cabbage in Tatkone Township and sesame in Magway Township were the most profitable mono crops in mono cropping. Chili was the second most profitable crop in Tatkone Township. For double cropping patterns, green gram-chilli cropping pattern was the most profitable crops in Yamethin Township and maize-cabbage cropping pattern was the most profitable crops in Tatkone Township. Green gram-cotton cropping pattern was the second most profitable crops in Yamethin and green gram-paddy cropping pattern was the second profitable crops in Tatkone Township. In addition, groundnut-cowpea cropping pattern was the second most profitable crops while groundnut-sesame cropping pattern was the most profitable in Magway Township.

Table 5.10 Gross margin analysis of mono cropping patterns in low diversified sample farm households in the Central Myanmar, 2016

Townships	Cropping Pattern	Amount per value (‘000MMK/ha)					BCR
		GB	TVC	TVCC	RAVC	RAVCC	
Yamethin (n=8)	Green gram	1,084	660	467	424	617	1.64
	Paddy	862	830	522	32	340	1.04
Tatkone (n=7)	Green gram	1,215	750	665	465	550	1.62
	Paddy	1,498	1,245	1,020	253	478	1.20
	Cabbage	4,163	2,144	1,715	2,109	2,448	1.94
	Chilli	3,285	1,750	803	1,535	2,482	1.88
	Maize	1,205	974	511	231	694	1.24
Magway (n=3)	Sesame	1,656	908	353	748	1,303	1.82

Note: GB= Gross Benefit, TVC= Total Variable Costs, TVCC = Total Variable Cost,
RAC= Return Above Variable Cost, RACC= Return Above Cash Cost, BCR= Benefit Cost Ratio

Table 5.11 Gross margin analysis of double cropping patterns in low diversified sample farm households in the Central Myanmar, 2016

Townships	Cropping Pattern	Amount per value ('000MMK/ha)					BCR
		GB	TVC	TVCC	RAVC	RAVCC	
Yamethin	GG-Chilli	4,891	2,468	1,814	2,422	3,076	1.98
(n=24)	GG-Cot	2,569	1,642	1,027	926	1,541	1.56
	GG-P	1,946	1,489	989	456	957	1.31
	P-Cot	2,347	1,812	1,083	534	1,264	1.30
	P-Pi	1,771	1,537	1,124	240	653	1.16
Tatkone	M-Cab	5,369	3,118	2,225	2,250	3,143	1.72
(n=16)	GG-P	2,713	1,994	1,685	719	1,028	1.36
	M-BG	2,230	1,757	1,143	472	1,086	1.27
	P-M	2,703	2,219	1,530	483	1,172	1.22
	M- Cp	2,165	1,820	1,011	344	1,153	1.19
Magway	GN-Ss	3,241	2,089	1,298	1,152	1,942	1.55
(n= 30)	GN-Cw	2,245	1,671	1,288	574	956	1.34
	GG+ Pi	1,769	1,464	1,145	305	624	1.21

Notes: GG= Green gram, Cot=Cotton, Cab= Cabbage, M= Maize Cp= Chick pea, P=Paddy, GN= Groundnut, Cw= Cowpea, BG= Black gram, Ss= Sesame, Pi= Pigeon pea, GB= Gross Benefit, TVC= Total Variable Cost, TVCC = Total Variable Cost, RAVC= Return Above Variable Cost, RAVCC= Return Above, Variable Cash Cost, BCR =Benefit Cost Ratio

5.8.2 Gross margin analysis for high diversified households

Gross margin analysis of multiple cropping for high diversified farm households in the study areas of Central Myanmar was indicated (Table 5.12). For the high diversified farm households group in Yamethin Township, BCR of green gram-paddy-chilli cropping pattern was 1.52 and gross margin per unit of land was 1,813,000 MMK per hectare. Cost of production was 3,479,000 MMK per hectare and gross benefit was 5,292,000 MMK per hectare in green gram-paddy-chilli multiple cropping. BCR of green gram mixed cotton followed by paddy cropping pattern was 1.24. Gross benefit of paddy-(green gram+ cotton) cropping was 3,711,000 MMK per hectare and it was cost 2,993,000 MMK per hectare for production amount of 717,000 MMK per hectare was obtained as gross margin per unit of land (net benefit). Moreover, Gross margin per unit of land of green gram-paddy-oilseeds (sunflower) cropping pattern gained amount of 1,221,540 MMK per hectare with 1.65 of BCR.

In Tatkone Township, BCR of cabbage followed by paddy and green gram cropping pattern was 1.54 and it was the most profitable crop in multiple cropping. Gross benefit was 6,389,000 MMK per hectare whereas cost of production was 4,150,000 MMK per hectare, gross benefit per unit of land was 2,238,000 MMK per hectare for high diversified farm households group who practiced green gram-paddy-cabbage cropping. BCR of maize-brinjal-chick pea cropping pattern was 1.40 and it was the second most profitable cropping pattern. Gross benefit (4,225, 000 MMK per hectare), cost of production (3,008,000 MMK per hectare) and then gross margin per unit of land (1,217,000 MMK per hectare) were found in maize-brinjal-chick pea cropping pattern. Gross benefit of maize-cow pea-sunflower cropping pattern was

2,656,000 MMK per hectare. Cost of production was 1,975,000 MMK per hectare and gross benefit per unit of land was 682,000 MMK per hectare. Therefore, BCR gained 1.35 in maize-cow pea-sunflower cropping pattern.

Furthermore, BCR of green gram-paddy-sesame cropping pattern was 1.32 and gross benefit was 3,718,000 MMK per hectare. Cost of production was 2,815,000 MMK per hectare and then gross margin per unit of land was 903,000 MMK per hectare. In addition, BCR of pigeon pea+ (green gram-groundnut) cropping pattern was 1.03 and gross benefit was 3,326,000 MMK per hectare. Cost of production was 3,216,000 MMK per hectare and then return per unit of land was 1,094,000 MMK per hectare in pigeon pea+ (green gram-groundnut) cropping pattern (Table 5.12).

In brief, green gram-paddy-cabbage cropping pattern was the most profitable crops in Tatkone Township than other patterns in Townships in multiple cropping. Green gram-paddy-chilli cropping pattern was the second most profitable crops in Yamethin Township in multiple cropping. Furthermore, the third most profitable cropping was green gram-groundnut-sesame cropping pattern in Magway Township in multiple cropping.

Table 5.12 Gross margin analysis of multiple cropping patterns in high diversified sample households practiced in the Central Myanmar, 2016

Cropping Pattern	Amount per value ('000MMK/ha)					BCR
	GB	TVC	TVCC	RAVC	RAVCC	
Yamethin (n=27)						
GG-P-Chili	5,292	3,479	2,364	1,813	2,927	1.52
P-(GG+ Cot)	3,711	2,993	2,000	717	1,710	1.24
GG-P-Oilseeds (Sun)	2,989	2,438	1,766	551	1,224	1.22
Tatkone (n=36)						
GG-P-Cab	6,389	4,150	3,147	2,238	3,242	1.54
M-Bringal- Cp	4,225	3,008	2,111	1,217	2,114	1.40
(M+ Cw)-Sun	2,656	1,975	306	682	2,350	1.35
GG-P-Ss	3,718	2,815	2,015	903	1,703	1.32
GG-P-GN	3,783	3759	2,504	23	1,278	1.01
Magway (n=19)						
GG-GN-Ss	4,159	3,491	2,338	667	1,820	1.40
M+ Cw- Ss	3,717	2,815	2,015	903	1,703	1.32
(Pi + GG)-Ss	3,326	3,216	2,213	1,094	1,112	1.03

Notes: P= Paddy, GG= Green gram, Sun = Sunflower, Cot= Cotton, GN= Groundnut, Cw = Cowpea, Ss=Sesame, M= Maize, Pi=Pigeon pea, GB= Gross Benefit, TVC= Total Variable Cost, TVCC = Total Variable Cash Cost, RAVC = Return Above Variable Cost, RAVCC= Return Above Variable Cash Cost, BCR = Benefit Cost Ratio

5.9 Labour Use Efficiency of Diversified Households in the Study Areas of Central Myanmar

5.9.1 Labour use efficiency for low diversified sample farm households

Labour productivity in various crops and different cropping patterns was shown (Table 5.13). For low diversified farm households who cultivated mono crop, the total labour used for green gram was 96.34 man-days per hectare and labour cost expensed 307,000 MMK per hectare. Low diversified farm households produced the crop value of 1,084,000 MMK per hectare and value of farm production per person from green gram cultivation was 11,252 MMK per hectare. Therefore, return per labour cost was 3.53 in Yamethin Township. This means that if one kyat was invested in labour cost, it was returned the profit amount of 3.53. Amount of labour in paddy cultivation of low diversified farm households group used 146.52 man-days per hectare and produced the value of 863,000 MMK per hectare. Thus, return per labour cost was 1.69 in Yamethin Township. Labour cost of paddy cultivation was 511,000 MMK per hectare and one labour produced value of 5,886 MMK from paddy cultivation (Table 5.13).

In Tatkone Township, value of 1,215,000 MMK per hectare for green gram cultivation was produced by low diversified farm households and number of labour in green gram cultivation used was 104.20 man-days per hectare. Then return per labour cost was 2.98. Labour cost of green gram cultivation was 408,000 MMK per hectare and one labour produced value of 11,660 MMK per hectare from green gram cultivation. In paddy cultivation as mono cropping, value of 1,498,000 MMK per hectare was produced by low diversified farm households. Amount of labour used was 134.05 man-days per hectare in paddy cultivation and labour cost was 588,000 MMK per hectare for paddy cultivation. Therefore, return per labour cost of paddy cultivation was 2.55 as one labour produced the value of 11,175 MMK from paddy cultivation in Tatkone Township. In cabbage cultivation of low diversified farm households who practiced mono cropping, value of 4,163,000 MMK per hectare was produced by low diversified farm households. Amount of labour used was 215.31 man-days per hectare in cabbage cultivation and labour cost was 961,000 MMK per hectare for cabbage cultivation. Therefore, return per labour cost of cabbage cultivation was 4.33 as one labour produced the value of 18,476 MMK from cabbage cultivation in Tatkone Township (Table 5.13). The value of farm production per

hectare was 3,285,000 MMK man-days per hectare and amount of labour used 234.23 man-days per hectare for chilli in Tatkone Township. Thus, labour cost of chilli cultivation was 855, 000 MKK per hectare and then return per labour cost gained 1.81 from chilli cultivation as mono cropping in Tatkone Township.

For low diversified farm households who cultivated double crops in a year, the amount of labour for green gram-chilli cropping pattern used 389.83 man-days per hectare and expensed amount of 1,648,000 MMK per hectare for labour cost in Yamethin Township. Therefore, one labour might produce amount of 12,547 MMK per hectare and then return per labour was 2.97 for green gram-chilli cropping in Yamethin Township.

In Yamethin Township, the value of farm production for a hectare was 9,609 MMK man per days in green gram-cotton cropping pattern and amount of labour used was 267.36 man-days in green gram-cotton cropping. Then, amount of 949,000 MMK per hectare was expensed for green gram-cotton cropping. Return per labour cost in this cropping was 2.71. Labour were used 242.59 man-days per hectare for green gram-paddy cropping pattern in Yamethin Township and cost of labour for green gram- paddy was 1,071,000 MMK per hectare. Furthermore, one labour produced the value of 8,026 MMK and return per labour cost was 1.82 from green gram-paddy cropping (Table 5.14).

In addition, labour used was 312.74 man-days per hectare in paddy-cotton cropping pattern in Yamethin Township and cost of labour for green gram- paddy was amount of 1,080,000 MMK per hectare. Furthermore, one labour produced the value of 7,505 MMK and return per labour cost was 2.17 from paddy-cotton cropping. Furthermore, return per labour cost and amount of labour used of paddy-pigeon pea cropping pattern were 2.12 and 253.27 man-days per hectare. Labour cost was 835,000 MMK per hectare and one labour produced amount of 6,992 MMK per a day in paddy-pigeon pea cropping.

In Tatkone Township, low diversified farm households produced value of 5,368,000 MMK per hectare and 351.62 man-days per hectare was used for maize-cabbage cropping pattern. Amount of 2,323,000 MMK per hectare were expensed for labour in those of cropping and one labour produced 15,269 MMK from maize-cabbage cropping. Thus, return per labour cost gained 2.31 in maize-cabbage cropping. In green gram-paddy cropping pattern, return per labour was 2.37 and one labour produced value of 11,390 MMK in Tatkone Township. Amount of labour used 238.25 man-days per hectare and amount of1, 146, 000 MMK per hectare were

Table 5.13 Labour use efficiency of low diversified sample farm households in mono cropping patterns in the study area, 2016

Townships	Cropping patterns	Value of products (‘000MMK/ ha)	labour used (md/ha)	Labour cost (‘000MMK /ha)	Value of farm production per person (MMK/md)	Return per Labour cost
Yamethin (n=8)	Green gram	1,084	96.34	307	11,252	3.53
	Paddy	863	146.52	511	5886	1.69
Tatkone (n= 7)	Green gram	1,215	104.20	408	11,660	2.98
	Paddy	1,498	134.05	588	11,175	2.55
	Cabbage	4,163	215.31	961	18,476	4.33
	Chilli	3,285	234.23	855	14,025	3.84
	Maize	1,205	157.62	664	7645	1.81
Magway (n= 3)	Sesame	1,656	93.24	508	17761	3.26

expensed for green gram-paddy cropping pattern. Return per labour of maize-black gram cropping pattern was 2.14 from labour used amount of 225.31 man-days per hectare. Amount of 1,044,000 MMK per hectare was expensed to labour cost and one labour produced 9,898 MMK from maize-black gram cropping. Furthermore, return per labour of paddy-maize cropping pattern was 1.95 while labour used amount was 291.67 man-days per hectare. Amount of 1,389,000 MMK per hectare was expensed to labour cost and one labour produced 9,268 MMK from paddy-maize cropping. Return per labour of maize-cow pea cropping pattern was 2.24 and labour used was amount of 221.90 man-days per hectare. Amount of 967,000 MMK per hectare was expensed to labour cost and one labour produced 9,757 MMK from maize-cow pea cropping in the low diversified farm households group.

In Magway Township, for farm households who practiced double cropping, return per labour cost were 4.10 in groundnut- sesame cropping. Labour was used amount of 229.82 man-days per hectare and expensed 789,000 MMK to labour cost. Then, labour from groundnut-sesame cropping pattern produced amount of 789,000 MMK per hectare (Table 5.14). Moreover, return per labour cost was 1.64 in groundnut-cowpea cropping. Labour was used amount of 231.05 man-days per hectare and expensed 1,368,000 MMK to labour cost. Then, labour from groundnut-cow pea cropping pattern produced amount of 789,000 MMK per hectare. Return per labour cost was 2.29 in green gram-pigeon pea cropping. Labour used amount of 214.80 man-days per hectare and expensed 771,000 MMK to labour cost. Then, labour from green gram-pigeon pea cropping pattern produced amount of 8,235,000 MMK per hectare.

Therefore, the results revealed that since return per labour cost was 3.53, green gram cultivation was the most labour efficiency in Yamethin Township. In Tatkone Township, since return per labour cost was 4.33, cabbage cultivation was the most efficiency in labour use and chilli (3.84 in labour use efficiency) was the second most labour efficiency. In Magway Township, since labour efficiency of sesame cultivation was 3.26, it was the most efficiency in labour for sesame cultivation in LDG. In double cropping pattern, green gram-chilli cropping in Yamethin Township and green gran-paddy cropping in Tatkone Township were the most efficiency in labour productivity. In Magway Township, since return of labour cost in groundnut-sesame cropping pattern was 4.10, it was the most efficiency in labour productivity.

Table 5.14 Labour use efficiency of low diversified sample farm households in double cropping patterns in the study area, 2016

Townships	Cropping Pattern	Value of products (‘000 MMK/ha)	Labour used (md/ha)	Labour cost (‘000 MMK/ha)	Value of farm production per person (‘000 MMK/md)	Return per labour cost
Yamethin	GG-Chilli	4,891	389.83	1,648	12,547	2.97
(n=24)	GG-Cot	2,569	267.36	949	9,609	2.71
	GG-P	1,947	242.59	1,071	8,026	1.82
	P-Cot	2,347	312.74	1,080	7,505	2.17
	P-Pi	1,771	253.27	835	6,992	2.12
Tatkone	M-Cab	5,368	351.62	2,323	15,269	2.31
(n=16)	GG-P	2,713	238.25	1,146	11,390	2.37
	M-BG	2,230	225.31	1,044	9,898	2.14
	P-M	2,703	291.67	1,389	9,268	1.95
	M-Cp	2,165	221.90	967	9,757	2.24
Magway	GN-Ss	3,241	229.82	789	14,106	4.10
(n= 30)	GN-Cw	2,245	231.05	1,368	9,716	1.64
	GG+ Pi	1,769	214.8	771	8,235	2.29

Notes: GG= Green gram, P=Paddy, Cot=Cotton, Cab= Cabbage, M= Maize, BG= Black gram, Cp= Chick pea, GN= Groundnut, Cw= Cowpea, Ss= Sesame, GB= Gross Benefit, TVC= Total Variable Cost, TVCC = Total Variable Cost, RAVC= Return Above Variable Cost, RAVCC= Return Above Variable Cash Cost, BCR =Benefit Cost Ratio

5.9.2 Labour use efficiency for high diversified sample farm households

For high diversified farm households who practiced multiple cropping patterns, the result indicated that the total labour used for green gram-paddy-chilli cropping pattern was 425.93 man-days per hectare and return per labour cost was 2.72 (Table 5.15). Therefore, one labour produced amount of 12,424 MMK from this cropping cultivation and labour expensed was 1,948,000 MMK.

Labour in high diversified farm households group used amount of 390.34 man-days per hectare and expensed amount of 1,394,000 MMK per hectare to labour for green gram-paddy-oilseeds (sunflower) cropping pattern in Yamethin Township. Since return per labour cost was 2.14, amount value of 7,657,000 MMK was gained by one labour's productivity. In addition, labour was used 478.53 man-days per hectare and expensed 1,951,000 MMK per hectare to labour in paddy-(green gram + cotton) cropping pattern. Therefore, one labour produced amount of 7,754 MMK and return per labour cost was 1.90 from paddy-(green gram+ cotton) cropping in Yamethin Township.

In Tatkone Township, labour of high diversified farm households used 453.36 man-days per hectare in green gram-paddy-cabbage cropping. Labour cost was amount of 2,011, 000 MMK per hectare. In addition, one person gained amount of 14,086 MMK in green gram-paddy-cabbage cropping. Therefore, return per labour cost was 3.18 in green gram-paddy-veg (cabbage) cropping.

Labour of high diversified farm households used 421.00 man-days per hectare in maize-veg (brinjal)-cow pea cropping pattern. Labour cost was amount of 1,894, 000 MMK per hectare. In addition, one person gained amount of 10,035 MMK. Therefore, return per labour cost was 2.23 in maize-veg (bringal)-cow pea cropping. In maize-cow pea-sunflower cropping, return per labour cost was 2.40 and labour was used 269.40 man-days per hectare. Amount of 1,108,000 MMK was expensed to labour cost and one labour produced 9,859 MMK for maize-cow pea-oilseeds (sunflower) cropping. Moreover, amount of 366.79 man-days per hectare was used in labour for green gram-paddy-oilseeds (sesame) cropping pattern in Tatkone Township. Amount of 1,498,000 MMK was expensed to labour cost and one labour produced 11,445 MMK in green gram-paddy-oilseeds (sesame) cropping pattern.

In Tatkone Township, amount of 402.22 man-days per hectare was used in labour for green gram-groundnut-paddy-oilseeds (groundnut) cropping pattern.

Amount of 1,572,000 MMK was expensed to labour cost and one labour produced 9,405 MMK in green gram-paddy-oilseeds (groundnut) cropping pattern.

In Magway Township, high diversified farm households group used 353.07 man-days per hectare in labour and expensed 1,466,000 MMK per hectare for green gram-groundnut-sesame cropping pattern. Therefore, one person produced amount of 11,779 MMK and then return per labour cost was 2.83. Furthermore, return of maize-cow pea-sesame cropping pattern was 1.49 and then amount of labour used (439.40) and 1,778 MMK per hectare were expensed to labour cost in this cropping. Therefore, one labour produced amount of 6,044 MMK from maize+ cow pea - sesame cropping pattern. Moreover, high diversified farm households group used 286.75 man-days per hectare in labour and expensed 1,113,000 MMK per hectare for (pigeon pea+ green gram) - sesame cropping pattern. Therefore, one person produced amount of 11,372 MMK and then return per labour cost was 2.93 in this cropping pattern (Table 5.15). Therefore, results revealed that capacity of labour used in chilli and cabbage was the highest for low diversified farm households compared to other crop productions. It means that chilli was the most efficient capacity in labour used in mono crop although chilli was the second most profitable crop.

5.10 Determinants of Crop Diversification Index in the Study Areas of Central Myanmar

According to the objective of this study, there are several factors influencing on crop diversification index. Therefore, it is essential to predict each dependent variable and to identify the variables which are influencing mainly on crop diversification index at the farm level.

In this study, the results of the model (Table 5.16) shows that diversification of farm households in their crop productions was depended on the number of crops, farm size, amount of credit received, schooling years of household heads, farm experience years, farm size, dependency ratio and non-farm income in the model. Farm households in Central Myanmar earned income not only from crop productions but also from other incomes such as non-farm to survive their livelihoods. The number of crops was highly negative and significant linked to crop diversification index at 1% level. It meant that 1% increase in number of crops would improve the crop diversification value by 0.066. It explained that larger the various crops were grown, the crop diversification value would be the best.

Table 5.15 Labour use efficiency for high diversified sample households in multiple cropping patterns in Central Myanmar, 2016

Cropping Pattern	Value of products (‘000 MMK/ha)	Labour used (md/ha)	Labour cost (‘000 MMK/ha)	Value of farm production per person (‘000 MMK/md)	Return per labour cost
Yamethin (N=27)					
GG-P-Chili	5,292	425.93	1,948	12,424	2.72
GG-P-Sun	2,989	390.34	1,394	7,657	2.14
P-(GG+ Cot)	3,711	478.53	1,951	7,754	1.90
Tatkone (N=36)					
GG-P-Veg (Cab)	6,389	453.56	2,011	14,086	3.18
M-Veg(Bringal)- Cp	4,225	421.00	1,894	10,035	2.23
M-Cw-Oilseed (Sun)	2,656	269.40	1,108	9,859	2.40
GG-P-Oilseeds (Ss)	3,718	366.79	1,498	11,445	2.02
GG-P-Oilseeds (GN)	3,783	402.22	1,572	9,405	2.40
Magway (N=19)					
GG-GN-Ss	4,159	353.07	1,466	11,779	2.83
M+ Cw - Ss	2, 656	439.40	1,778	6,044	1.49
(Pi + GG) -Ss	3, 261	286.75	1,113	11,372	2.93

Notes: P= Paddy, GG= Green gram, Sun= Sunflower, Cot= Cotton, GN=Groundnut, Cw = Cowpea, Ss=Sesame, M= Maize

In the case of amount of credit, it was negatively related to crop diversification index. It implies that the amount of credit for individual farm household was limited to their lands even though farm households had the large farm size. If farmers had more opportunity to obtain adequate credits, they might invest to extend crop diversification. As a result, they could especially pay labour costs and machinery costs. In other words, farm households reduced to use hired labour in the crop productivity. For that reason, credit available might be low in purchasing power to extend crop diversification or labour might be difficult to hire. In addition, they could buy required materials. If farm households received the sufficient credit, they could invest to increase crop diversity without risks of informal credits. Therefore, amount of sufficient credits was required to invest especially in high costs of crop production for boosting crop diversification.

Farm household head's schooling years was essential to determine whether crop diversification was increased or not. Farm household head's schooling years was negatively significantly influenced on crop diversification although it was not significant. It could be interpreted that the smaller in schooling years of farm household heads, the greater crop diversification index would be. It means that since farm households had low schooling years, they were weak in access to improved technologies and consequently farm households in the study area practiced low diversified farming.

The calculated coefficient indicated that farm experiences were positively related to crop diversification index though not significant. It means that increasing one percent in farm experiences of farm household heads could lead to boost crop diversification value in 0.002. It could be interpreted that if farm household heads worked for several years in farm activities, crop diversification index would be small. Therefore, farm households practiced high diversified farming in the study area.

According to the results, the coefficient of farm size was negatively and highly significant related to crop diversification index at 1% level. It indicated that the larger the farm size was, the smaller the crop diversification value would be. In other words, 1% increase in farm size would reduce the crop diversification value by 0.066. It showed that farm size was quite important for crop diversification in the study areas.

In addition, dependency ratio was negatively related to crop diversification

index. However, it was not significant. It explained that 1% increasing in dependency ratio would reduce crop diversification value in 0.008. It means that the greater the number of farm households depending on farm, the smaller the crop diversification value would be. In other words, it indicated that farm households practiced high diversified farming widely.

Finally, the coefficient of non-farm income was positively related to crop diversification although it was not significant. It indicated that if non-farm income of farm households increased by 1%, crop diversification value would be increased by 0.009. Therefore, the result can be interpreted that farm households practiced low diversified (specialized) farming. In the other words, families are doing other works in addition to the farming to earn the extra income for investing their farms.

The F-value indicated that the model was significant at 1% level. The adjusted R square pointed out that the model was significant and it can explain the variation in crop diversification in the study area.

Table 5.16 Determinants of crop diversification index of sample farm households in Central Myanmar, 2016

Items	Unstandardized		Standardized	t- test	Sig.
	β	Std. Error	Beta		
(Constant)	1.022***	0.075		13.552	.000
Lnnumber of crops	- 0.145***	0.008	- 0.771	- 17.761	.000
Lnamount of credit	- 0.003 ns	0.002	- 0.064	- 1.512	.132
Lnschooling years	- 0.032ns	0.022	- 0.070	- 1.492	.138
Lnfarming experiences(years)	- 0.002	0.014	- 0.008	- 0.177	.860
Lnfarm size	- 0.039***	0.011	- 0.148	- 3.437	.001
Lndependency ratio	- 0.008	0.005	- 0.063	- 1.481	.141
Lnnon-farm Income	0.004	0.003	0.060	1.398	.164

R^2= 0.722

Adjusted R^2= 0.710

F value = 60.134***

Dependent variables = Crop diversification index

Note: *** indicates statistical significance at 1% level and ns denotes non- significant.

CHAPTER VI

SUMMARY, CONCLUSION AND RECOMMENDATIONS

6.1 Summary of the Study in Southern Shan State

The study was conducted to investigate crop diversification and socioeconomic situations of farm households at Hsihseng, Pindaya and Nyaung Shwe Townships in Southern Shan State. Although the survey was done during the period of 2013, the research analysis could be covered to socioeconomics characteristics, land area and cropping patterns and the degree of crop diversification. In other word, lack of conversion factors for measurement of agricultural products, data analysis might take time so that the findings did not cover all the objectives of the study. Thus, data analysis did not cover all the objectives of the study.

The farm households were divided into two groups: low diversified group and high diversified group, based on their crop income using Herfindahl method. The results indicated that 60% of farm households was included in low diversified group because their Herfindahl index ranged from 0.50 to 1.00 and average crop diversification was 0.81. About 40% of diversified farm households group was in high diversified farming group. Their diversification was found in the range of 0.00 to 0.49 with average crop diversification index 0.39.

According to the results, family size in both groups was 5 persons per household on average. Schooling years of 76.6% of low diversified farm households was in primary education compared to 35% of high diversified farm households. However, 35% of high diversified farm households had high education level compared to 5.6% of low diversified farm households. Over two-third of farm households (77.8%) in both groups were male headed households. Dependency ratios of both diversified farm households groups were less than 50% in the study areas.

In southern Shan State, low diversified farm households owned an average 1.9 hectares of cultivated land whereas high diversified farm households possessed 2.9 hectares in average. In Central Myanmar, the farm size owned by low diversified farm households was 2.8 hectares on an average and 3.9 hectares in high diversified farm households. Most of low diversified farm households (60%) owned below 2 hectares significantly than high diversified farm households (40%). Therefore, low diversified farm households who cultivated small area was higher than high diversified farm households in the study areas. In high diversified group, 13% of

farm households owned the land area above 4.01 hectares.

The results revealed that farm households cultivated the various crops including paddy, maize, chick pea, wheat, sugarcane, ginger, oilseeds and vegetables. It is observed that 40% and 60% of low diversified sample farm households cultivated mono and double cropping patterns, respectively. However, 48.3%, 28.3% and 23.3% of high diversified farm households cultivated multiple croppings with three, four and more than four, respectively.

According to the findings of the study, maize was cultivated on 39.2% of growing area. Maize growing land size was an average of 2.94 hectares in low diversified group and 1.71 hectares in high diversified group. Maize occupied 32% of total cultivated land in high diversified group.

Paddy was cultivated on 37.3% of growing area. Paddy growing land size was an average of 1.49 hectares in low diversified group and 1.07 hectares in high diversified group. Paddy occupied 37.3% of total cultivated land in high diversified group. An average area of sugarcane (0.92 ha) was cultivated and occupied 12% of total in low diversified group. In high diversified group, an average cultivated area of groundnut was 0.60 hectares and it occupied 7.8% of total sown area. Average sown area of tomato, mustard and other crops were 0.55 hectares, 0.63 hectares and 1.1 hectares. Among cultivated areas, maize was mostly cultivated with the highest percentage of land area. Therefore, maize was the most important cash crop and paddy was cultivated as staple food crop in both groups. Moreover, sugarcane was vital to industrial crop for LDG.

According to the results, 21.1% and 31.2% of low diversified farm households in Hsihseng and Nyaung Shwe Townships practiced mono cropping. However, 58.4% of farm households in Pindaya Township mostly practiced multiple cropping patterns. Farm households mainly cultivated rice-based cropping pattern and maize-based cropping pattern such as paddy-oilseeds-vegetables, maize-oilseeds-vegetables and paddy-vegetables-other crops. In addition, vegetables-vegetables-vegetables cropping was observed in the study areas of Southern Shan State. Cropping intensity index was in 109% in low and 133% in high diversified farm households, respectively. The lower cropping intensity was attributed to the practice of mono crop such as sugarcane and maize for the entire cropping season. Due to the cultivation of various cropping patterns, total effective acreage was 228.7 hectares in the high diversified group. Therefore, it could be explained that there was

a higher chance of crop diversification with increasing cropping patterns. However, it could be low cropping intensity due to growing perennial crop like sugarcane having long growing period.

In agricultural credit sector, 61% of total farm households from both groups received credit from MADB, 39% of total farm households from informal credit and 22.5% of total farm households from UNDP and other organizations. However, 35.4% of low diversified farm households and 42.1% of high diversified farm households could invest their own capital in their crop productions without taking credits. For this reason, it can be assumed that farm households wanted to avoid the risk of interest rates on loans.

An average value of credit received from MADB was 50,000 MMK per hectare for low diversified group and 45,000 MMK per hectare for high diversified group. Money from lenders paid credit amount of 154,000 MMK per hectare and 192,000 MMK per hectare for low diversified farm households group and high diversified farm households group. UNDP and other organizations gave the credit amount of 98,000 MMK per hectare for LDG and 113, 000 MMK per hectare for high diversified farm group.

Constraints and problems challenged by both diversified groups were less access to technology, less exposure to extension staff, insufficient inputs, financial difficulty, and low market price of crops, pest infestation and drought in the study areas. Constraints in low access of technology were significantly different between two groups. Low diversified group faced comparatively more serious than high diversified group in all constraints problems. Therefore, farm households expected to obtain more extra earnings in crop production without risks for their livelihoods.

Output included in the regression model were number of crops, amount of credit received by farm households, schooling years, farming experiences and farm size and dependency ratio. Farm household heads who had many schooling year could make the best decisions in farm activities to lead the crop diversification for increasing crop income. As long as farm households would have more opportunity to obtain higher enough credit, they were likely to cultivate new crops and they might more investing in crop diversification especially paying labour costs, buying materials needs and paying machinery costs. Moreover, farm households would choose more profitable value crops which probably might be with high cost of production.

6.2 Summary of the Study in Central Myanmar

The economic perspective of crop diversification in terms of profitability, land use efficiency and determinants of crop diversification was explored in this study area. The study investigated identification of the crop diversification of farm households and the socioeconomic situations within the diversified farm households in Central Myanmar. The household survey included a total of 170 sample farm households from Yamethin, Tatkone and Magway Townships in Central Myanmar. The two groups, low diversified and high diversified, were categorized to evaluate the crop diversification based on the farm income by using Herfindahl index method. The results indicated that 52% of farm households had low diversified farming with H_d index ranging from 0.51 to 1.00. Forty percent of total farm households had high diversified farming and its diversification intensity ranged from 0.00 to 0.50 in H_d index.

Most farm households (83% and 78% of low and high diversified farm households) were headed by males. Average family number in both groups was 6 persons. Low diversified farm household heads (64.4%) and high diversified farm household heads (56.9%) had primary education level. However, high diversified farm household heads (30%) had middle education level. Average dependency ratio in both groups reached about 47%. It indicated that two persons in working age group supported every one young or aged person.

An average farm size owned by low diversified farm households was 2.8 hectares and 3.9 hectares in high diversified farm households. In specific, low diversified farm households group (29.5%) and high diversified group (18.3%) owned less than 2.0 hectares in the study area. However, high diversified group (32.9%) and low diversified group (22.7%) owned over 4.01 hectares. Most farm households in both diversified farm groups (nearly 50%) possessed farm size between 2.01 hectares and 4.0 hectares. In the study area, farm households cultivated paddy, green gram, sesame, groundnut, pigeon pea, maize, cotton as major crops. Although the same crops were grown by both groups, low diversified group grew comparatively larger cultivated areas for sesame (4.92 hectares) and groundnut (3.49 hectares). Average sown area of green gram and paddy were not different between two groups.

According to the results, legume-based cropping pattern and rice-based cropping pattern observed in the study area. In Yamethin Township, farm households

(13.6%) and farm households (11.9%) in Tatkone Township mostly practiced mono cropping. Farm households (40.7%) in Yamethin and 57.7% of farm households in Magway Townships practiced double cropping. However, 61.0% of farm households in Tatkone Township comparatively practiced multiple cropping patterns than Yamethin Township (45.8%) and Magway Township (36.5%). Common multiple cropping patterns were green gram-paddy-chilli in Yamethin, green gram-paddy-cabbage in Tatkone and green gram-groundnut-sesame in Magway. Legume based cropping pattern was widely cultivated in the study area. Average cropping intensity of low diversified farm households was 134% and 179% intensity for high diversified farm households. Farm households earned not only crop income but also livestock income to survive their life in the study areas. Income sharing of high diversified farm households (47%) was greater than that of low diversified farm households (31%) from crop production. However, LDG (50%) earned income from non-farm to alive than high diversified farm group.

The result of gross margin analysis from mono cropping in low diversified group showed that cabbage with BCR 1.94 was the most profitable crop and the highest gain crop in return per labour (4.33). Chilli was the second most profitable crop in 1.88 of BCR and labour return was 3.84 in Tatkone Township. In Magway Township, sesame of BCR 1.82 was the highest profit in mono cropping with 3.26 of return per labour.

For double cropping patterns, in Yamethin Township, green gram-chilli cropping pattern was the highest profit with BCR 1.98. In Tatkone Township, BCR of 1.72 in maize-cabbage cropping pattern was the most profitability and the second highest gain crop in return per labour (2.31). In Magway Township, BCR of 1.55 in groundnut-sesame cropping pattern was the most profitability and the highest gain crop in return per labour (4.10).

For high diversified group in Yamethin Township, BCR of 1.52 in green gram-paddy-chilli cropping pattern was the most profitable pattern and the highest gain cropping in term of labour return (2.72). In Tatkone Township, BCR of 1.54 in green gram-paddy-cabbage cropping pattern was the most profitable cropping patterns and return per labour (3.18) was the highest. In Magway Township, BCR of 1.40 in green gram-groundnut-sesame cropping pattern was the most profitable cropping. However, it was the second highest gain cropping in return per labour (2.83). In Tatkone Township, BCR of 1.54 in green gram-paddy-cabbage cropping pattern was the most profitable cropping patterns and return per labour (3.18) was the

highest.

The results of labour productivity were determined to compare two diversified farm groups based on the value of farm production per person, labour used per hectare and labour cost per hectare. In Yamethin Township, green gram cultivation produced 11,252 MMK per man-days in capacity and return per labour was 3.53 using 96.34 man-days per hectare in labour. In Tatkone Township, cabbage cultivation obtained 18,476 MMK per man-days and return per labour was 4.33 using 215.13 man-days per hectare in labour. In Magway Township, sesame cultivation produced 17,761 MMK per man-days and return per labour was 3.26 by using 93.24 man-days per hectare in labour.

In double cropping pattern, return per labour of groundnut-sesame, green gram-chilli and green gram-paddy cropping patterns were 4.10, 2.97and 2.37, respectively, and they were the highest gained cropping patterns. Groundnut-sesame cropping pattern produced 14,106 MMK per man-days by using 229.82 man-days per hectare of labour. Furthermore, green gram- chilli and green gram-paddy cropping patterns produced 12,547 MMK and 11,390 MMK per man-days in capacity.

In multiple cropping patterns practiced by high diversified farm households, return per labour of green gram- paddy-cabbage, pigeon pea+ (green gram- sesame) and green gram-paddy-chilli cropping patterns were 3.18, 2.93 and 2.72, respectively, and they were the high return per labour. In Yamethin Township, for green gram-paddy- chilli cropping pattern, value of farm production per person was 12,427 MMK and labour amount was 425.93 man-days per hectare. In Tatkone Township, value of farm production for green gram- paddy-cabbage cropping pattern was 14.086 MMK per person and used labour amount of 453.36 man-days per hectare. In Magway Township, for pigeon pea+ (green gram- sesame) cropping pattern, value of farm production per person was 11,372 MMK and used labour amount of 286.75 man-days per hectare.

The variables influencing on crop diversification were assumed to be farm size, amount of credit, number of crops, schooling years of farm households heads, farm experience, non-farm income and dependency ratio in the study area of Central Myanmar. According to the results of regression model, the greater the farm size was, the smaller the value of crop diversification would be. This meant that the more high value crops are cultivated, the more their income will increase. Therefore, farm

size and number of crops might be explained the factors significantly influenced on crop diversification of farm households in the study areas.

6.3 Conclusion

The study was not conduct primarily to make the comparison between Southern Shan State and Central Myanmar. It tried to have a picture of crop diversification in two different agricultural areas. Based on the findings, it might be concluded that the farm households depended on farm activities in both study areas. Although farm households cultivated cash crops as an economic choice as much as possible, it was observed that they could not grow well high crop diversification in both regions.

Among the various sown crops, maize-based cropping pattern and rice-based cropping pattern were mostly practiced in Southern Shan State. Maize and vegetables were economic cash crops and paddy was main food for home consumption in Southern Shan State.

In Central Myanmar, legume-based cropping pattern, oilseed-based and rice-based cropping pattern were primarily practiced. The low diversified households cultivated these crops in mono (10.5%) and double (41.2%) cropping patterns. However, 28.2%, 14.1%, 4.1% and 1.8% of high diversified farm households cultivated three, four, five and six crops in multiple croppings. Green gram, sesame, groundnut and paddy were mostly cultivated. Sesame was cultivated on one-third of total sown areas and groundnut was sown a quarter of total sown areas in the low diversified farming. Green gram was cultivated a quarter of total sown areas in the high diversified farming in Central Myanmar.

The education was one of the important factors to adopt the advanced technologies to lift up the lives of farm households. This study pointed out that schooling years of both diversified farm households (64.4% and 56.9%) were at primary level in both two regions. Therefore, in short-run, vocational education training linked to agricultural technologies are needed to educate farm households for boosting crop productivity and crop diversification. Moreover, the constraints faced by farm households pointed out that an effective extension services was needed for farm households to increase their productivity. The government should strengthen to support for extension services qualitatively and quantitatively. In addition, adequate funds should be provided to enable the extension staffs to lay out the model farms

and demonstration plots.

In addition, the credit for farm households received from MADB was very low and insufficient. It is necessary to improve access to credit in the study areas. Thus, credit programs are needed to increase and extend the rural credit programs to support adequately farm households' requirements for their crop productions by linking government agencies and financial institutions. Agriculture included not only crop production but also livestock production in Central Myanmar. However, farm households depended mainly on crop production for source of income to survive the livelihoods. For that reason, livestock production is needed to be encouraged and expanded widely to invest in increasing farm diversification and upgrading livelihoods of farm households.

According to gross marginal result, green gram, cabbage and sesame were the most profitable crops for low diversified farm households. Double or multiple cropping patterns based on these profitable crops were also profitable cropping patterns. Thus, these crops are needed to expand cultivation as mono or double cropping economically.

6.3.1 Factors influencing on crop diversification index of farm households

Farm households' basic socioeconomic situations played a vital role in crop diversification. The factors influencing on crop diversification in the southern Shan State includes number of crops, amount of credit, schooling years, farming experiences, farm size and dependency ratio. Number of crops and farm size were negatively and highly significant relationships related to crop diversification index. Amount of credit and schooling years were negative relationship. Farming experiences and dependency ratio were positive relationship in the model. Farm size was significant at 1% level, indicating that changing in large farm size might increase the crop diversification. Then, the number of crops is significant at 1% level, indicating that the greater the numbers of crops are grown the higher the crop diversification will be in the southern Shan State.

The possible significant determinants for crop diversification in Central Myanmar consists of number of crops, amount of credit, schooling years of headed households, farm experience years, farm size and dependency ratio. These factors were negatively and highly significant relationships related to crop diversification index. A positive relationship was only non-farm income in the model. Farm

households which could earn high non-farm income might not practice diversified farming. Farm size was significant at 1% level, indicating that increase in farm size might increase the crop diversification. Then, the number of crops is significant at 1% level, indicating that the greater the numbers of crops are grown the higher the crop diversification will be in the study areas.

6.4 Suggestions and Policy Implementation

Nowadays, choosing suitable cropping practices become a vital role of agricultural sector for extra earning income in nation. Myanmar is agro-based country which has targeted to high yielding productivity (production-oriented) since 1994 for food sufficiency. Myanmar still mainly emphasized intensive rice production system. Crop diversifying system should be implemented in place of intensive rice production system todays. After 2012, the opportunities to change into crop diversification become acceleration for economic growth and improve livelihoods of rural people. Crop diversification gives farmers a profitable livelihood while conserving agricultural resources and environmental quality. Crop diversification, therefore, become as an essential issue to establish market-oriented economy system of nation.

This study clearly indicated that vegetable-based cropping patterns in which cash crops are included as well as high value crops should be widely designed and enhanced to increase crop diversification according to the agro-ecological zone. The appropriate vegetable-based cropping system should be economically profitable to farmers in long term in two study regions. In Central Myanmar, the most profitable and labour use efficiency cropping patterns were also revealed for crop diversified farms. Therefore, maize, paddy, sugarcane and tomato crops in southern Shan State and green gram, sesame, cabbage and chilli in Central Myanmar are needed to cultivate widely as various cropping patterns with good agricultural practices (GAP) for increasing diversified farming.

To promote crop diversification of farm households in both study areas, agricultural policies, firstly, should be considered to prioritize the development of farm households' level. Effective agricultural policies and programs should focus to raise efficiently the level of resource use of farm households in crop productions. Policies oriented towards trading markets, closer to farmers should be considered to promote and support effectively to farm households. Market is an indicator of market

access to economic resources by investing reliable and adequate market infrastructure. In most cases, a lack of market infrastructure drives a section between the market price and the prices that farmers receive from their crop products. Thus, lowering the profits was found to be associated with fluctuation in crop diversification. Therefore, infrastructures like farm to market roads and access to market can play major role in enhancing diversification among rural households in the study area.

Secondly, credit programs, should be concentrated to promote effectively and especially provide to low resources of farm households in farming. Farm households grumbled of inadequate production capital and limited availability of land. In the study areas of Central Myanmar, there was rare any processing for green gram, cabbage, sesame cultivations, with which all of their production were sold to the local markets nearby. It is also true in southern Shan State, as lack of processing and harvest technology for maize, sugarcane and vegetables. Therefore, access to market information needs to be given close attention for farm households to avoid risk and to ensure farm returns. Farm machinery especially processing machines should be provided through easy loan schemes. Furthermore, investment in postharvest technology projects would also save the farm household's income.

In addition, since the study areas were rainfed areas, more crop diversification is needed to increase income generation and lift up living standards of farm households especially for small farmers. Due to erratic unseasonal rainfall, profitability of crop productions is uncertain. To overcome this situation, non-farm employment opportunities for example rearing livestock should be widely created by providing loans in short term. In addition, farm activities' opportunities should be promoted since it was positively related to crop diversification.

Thirdly, proper advanced technologies related to crop productions were mostly limited and extension services and training courses were insufficient. Local authorities, therefore, should provide widely to improve and strengthen extension services to increase crop diversification. It is urgently required to support by government staff from department of agriculture and cooperative institutions.

The study pointed education out as an importance key to adopt the new technologies for increasing crop diversification. Therefore, agricultural training programs with efficient technologies should be created to sustain crop diversified farming at farm household level. Moreover, as the farm households in Central

Myanmar were poor labour in resource, they had low level of crop productions. Thus, the government should expand implementation of its policies especially in mechanization for agricultural production through provision of farm equipment and implements.

Furthermore, farm households require to acquired skills, knowledge and farming experience for sustainable income generating activities. Therefore, technological dissemination such as provision of training, demonstration plots, the extension education services associated with agricultural technologies, new advanced technological packages which increased crop diversification should be promoted and implemented to increase crop productivity and income to being lifted up the living standards of farmers. As education program, training and technologies to sustain resource management, involvement of development agencies should be encouraged and promoted in the study area.

Therefore, it is suggested that planners and decision makers should make plans and design to create sustainable markets to strengthen the profits for farm households, which should be circulating beyond the local and regional market chain. As a result, crop diversification would enhance to increase crop productivity and profitability of farmers within the national food sufficiency in future.

In brief, crop diversification is a key strategy for agricultural development and economic growth. Crop diversification can be facilitated by technology improvement, by making changes in consumer demand or in agricultural policy and by enhancing in irrigation development, transportation and other related infrastructure. Moreover, it can be hampered by risks in crop management practices, in markets and prices, by degradation of natural resources, and by conflicting socio-economic conditions and self-sufficiency in particular crop. These are essential factors be considered and investigated in further studies of agricultural diversification research.

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APPENDICES

(A) Maps of Study Areas in southern Shan State, 2013

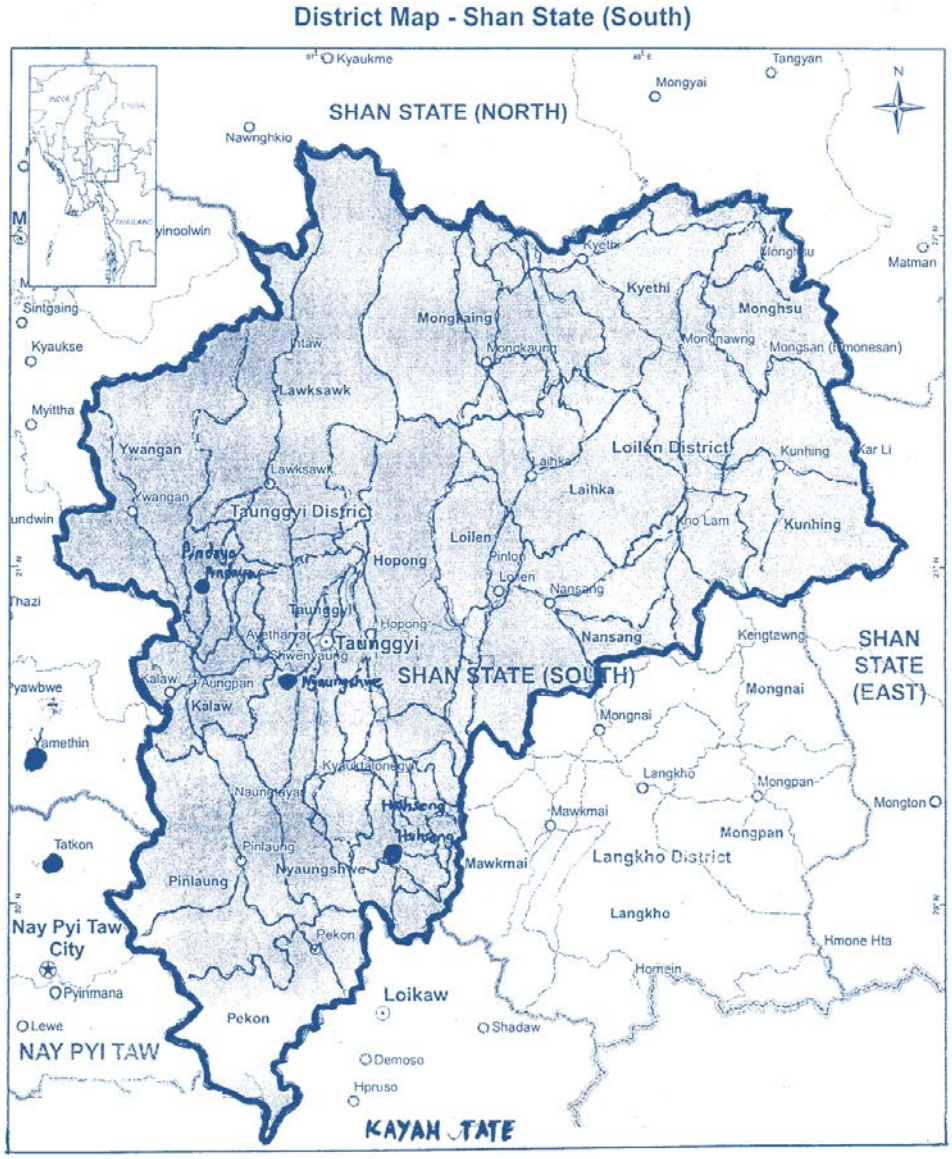

Figure 1 Study areas of southern Shan State, Myanmar

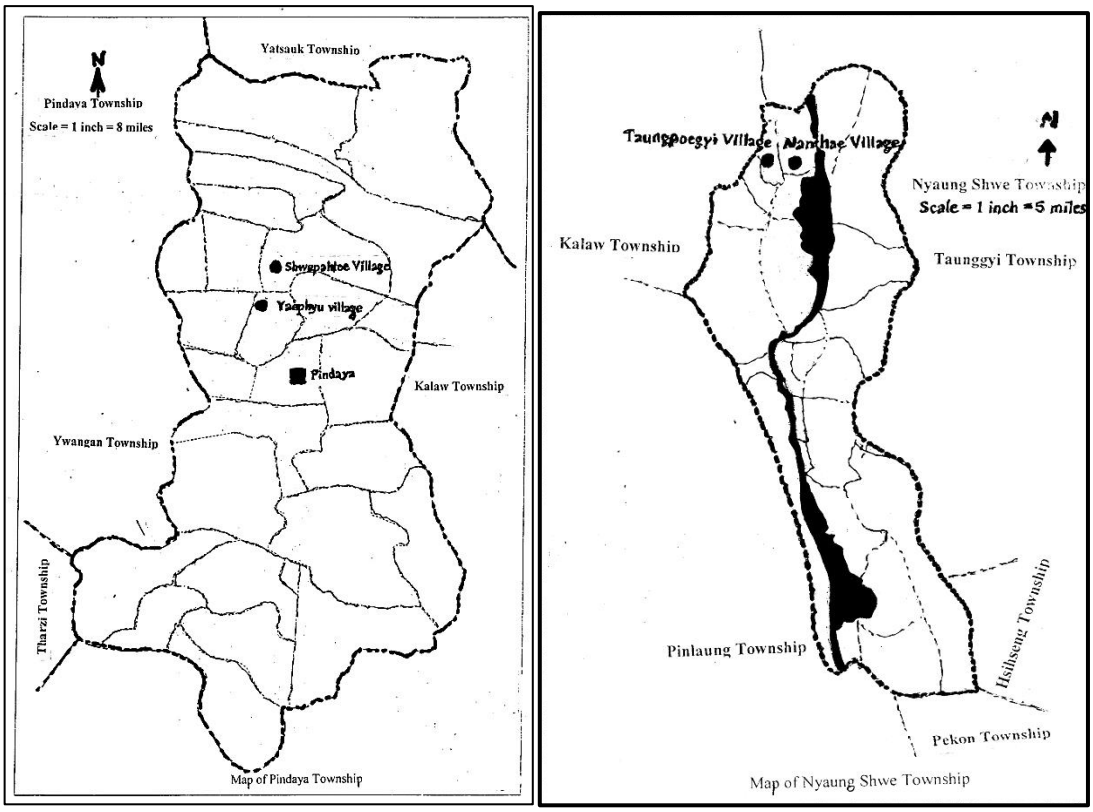

Figure 2 Maps of Pindaya Township and Nyaung Shwe Township

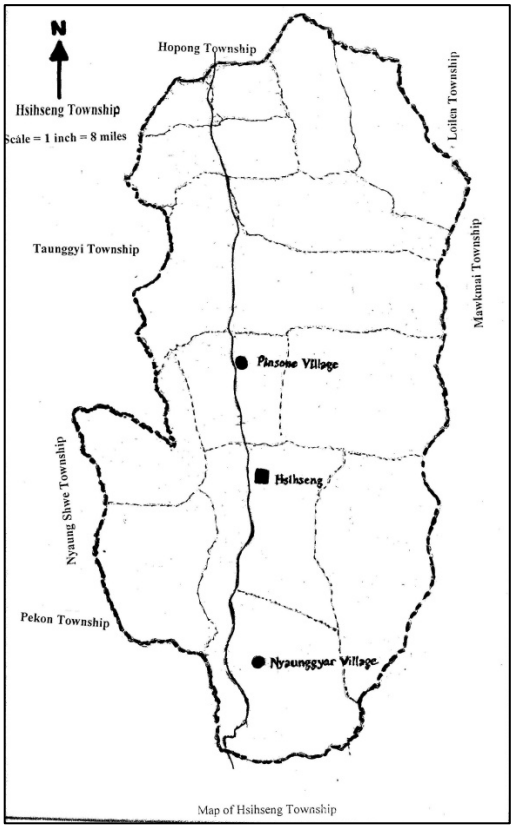

Figure 3 Map of the study areas in Hsihseng Township, southern Shan State

(B) Maps of the study areas in Central Myanmar, 2016

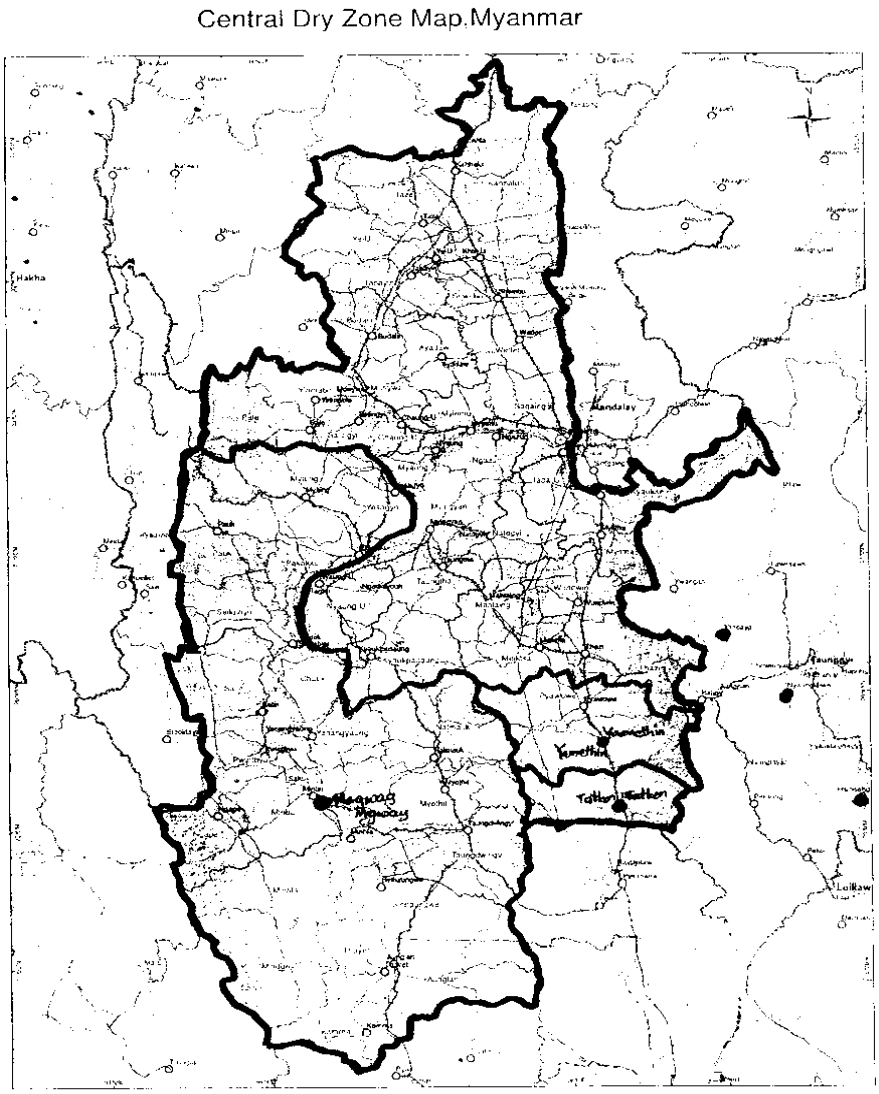

Figure 4 Study areas in the regions of central, Myanmar

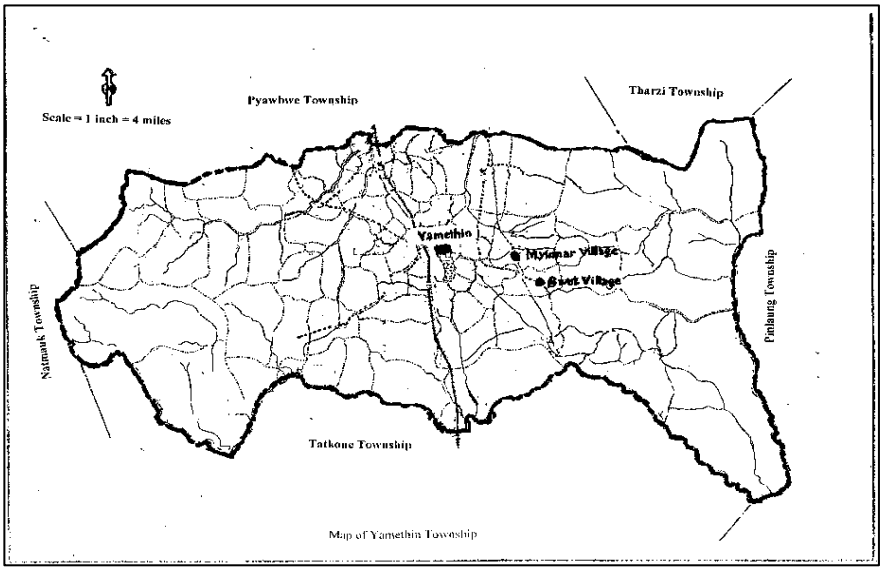

Figure 5 Map of Yamethin Township in Central Myanmar

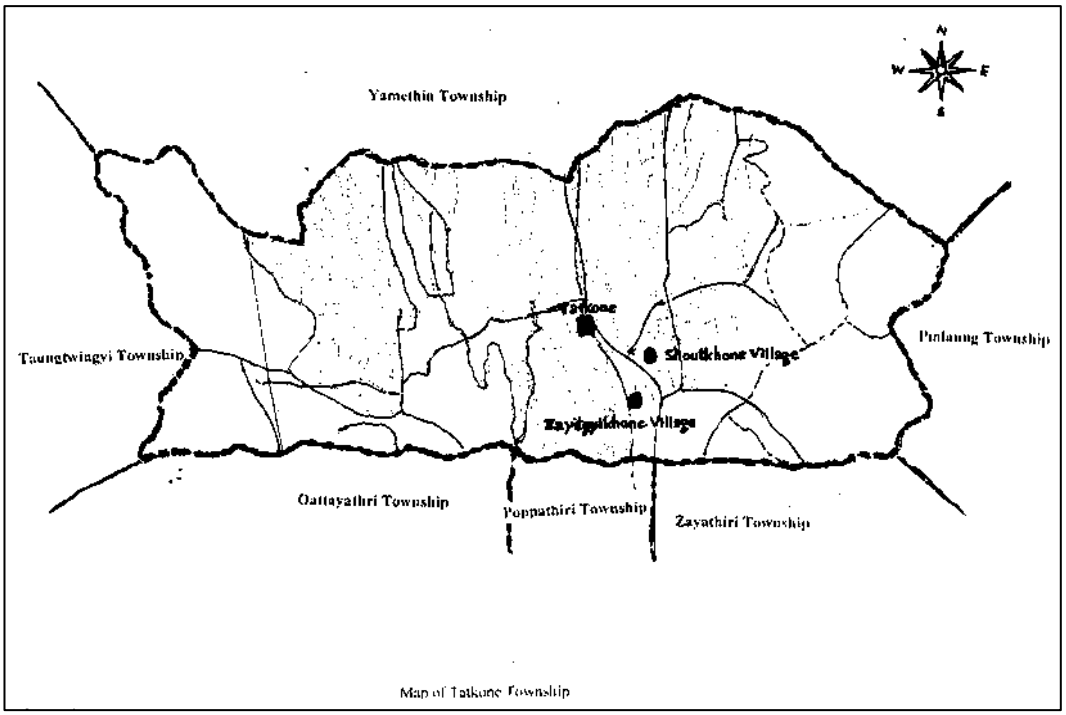

Figure 6 Map of Tatkone Township in Central Myanmar

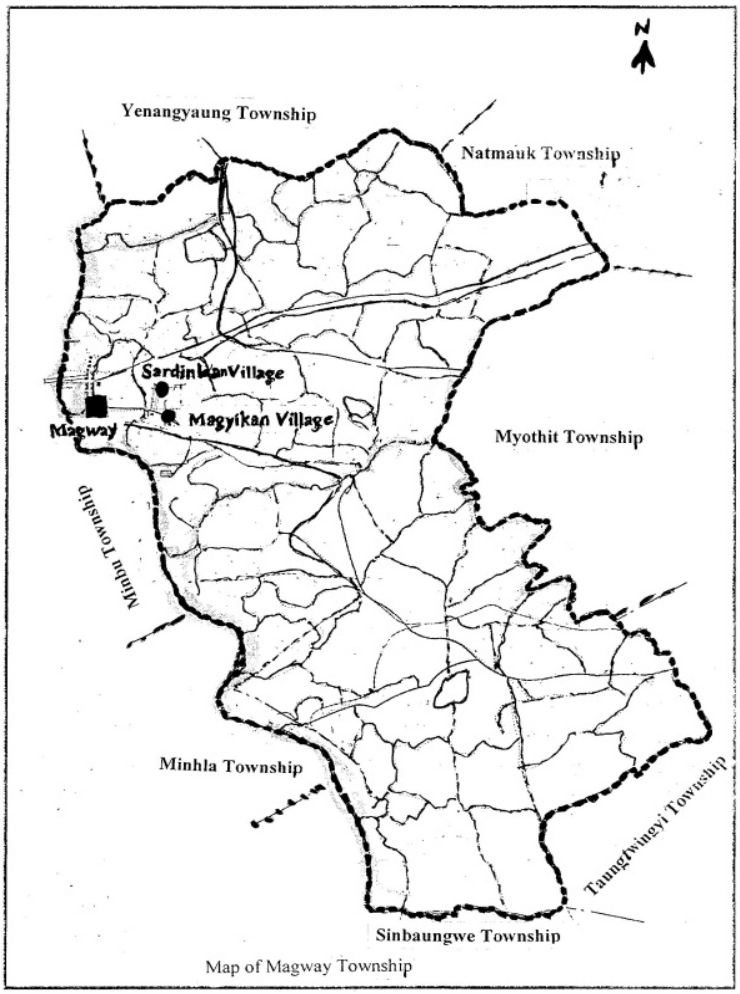

Figure 7 Map of Magway Township in Central Myanmar

(C) Crop Diversification in Southern Shan State, 2013

(i)Cabbage cultivation

(ii) cabbage and sugarcane

(iii) mustard cultivation

(iv) sugarcane cultivation

(D) Crop Diversification in Central Myanmar, 2016

(i) Pigeon pea cultivation

(ii) Rice and Pigeon pea cultivation

(iii) Rice and Pigeon pea cultivation

(iv)Sunflower cultivation

(v) Maize cultivation

(vi) Groundnut cultivation

(vii) Groundnut cultivation

(viii) Pigeon pea and Groundnut cultivation